Growdon Gate/Road Relocation and Property Acquisition Draft Environmental Assessment Volume II - Appendices

United States Air Force
Air Education and Training Command
802nd Civil Engineering Squadron
Joint Base San Antonio - Lackland, Texas

October 2012

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DEPARTMENT OF THE AIR FORCE
502D AIR BASE WING
JOINT BASE SAN ANTONIO

3 0 APR 2012

Edward L. Roberson, P.E.
Chief, Asset Optimization
802 CES/CEAO
1555 Gott Street
Lackland AFB TX 78236-5645

Ms. Lisa Jackson
Administrator
USEPA
Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202

SUBJECT: Growdon Gate/Road Relocation and Property Acquisition Environmental Assessment at Lackland Air Force Base, Texas

Dear Ms. Jackson,

The 802d Civil Engineer Squadron (CES) at Lackland Air Force Base (AFB) TX is preparing an *Environmental Assessment* addressing the *Growdon Gate/Road Relocation and Property Acquisition at Lackland Air Force Base, Texas*. The environmental impact analysis process for this EA is being conducted by the Air Education and Training Command (AETC) and 802 CES in accordance with Council on Environmental Quality regulations pursuant to the requirements of the National Environmental Policy Act (NEPA) of 1969.

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In accordance with Executive Order 12372, *Intergovernmental Review of Federal Programs*, we request your participation in the NEPA process by providing comments on the Proposed Action and any potential environmental consequences that might concern you. To facilitate cumulative impact analysis, we would appreciate identification of major projects in the vicinity that may contribute to cumulative effects. Please provide written comments or information at your earliest convenience but no later than 30 days from the date of this letter. We have also attached a listing of federal, state, and local agencies that have been contacted. If there are additional agencies that you feel should review and comment on the proposed activities, please include them in your distribution of this letter and the attachments. When complete, we will mail a copy of the Draft EA and the proposed Finding of No Significant Impact, if applicable, for your review.

Please address your questions or comments on the DOPAA by mail to Mr. Andrew Riley, P.E., 802 CES/CEAOP, 1555 Gott Street, Lackland AFB, Texas 78236-5645.

Sincerely

Edward L Roberson

EDWARD L. ROBERSON, P.E.

Attachments:
1. Figure showing location of Proposed Action
2. Distribution List

DEPARTMENT OF THE AIR FORCE
502D AIR BASE WING
JOINT BASE SAN ANTONIO

3 0 APR 2012

Edward L. Roberson, P.E.
Chief, Asset Optimization
802 CES/CEAO
1555 Gott Street
Lackland AFB TX 78236-5645

Mr. David Frederick
Field Supervisor
U.S. Fish and Wildlife Service
10711 Burnet Road, Suite 200
Austin, TX 78758-4460

SUBJECT: Growdon Gate/Road Relocation and Property Acquisition Environmental Assessment at Lackland Air Force Base, Texas

Dear Mr. Frederick,

The 802d Civil Engineer Squadron (CES) at Lackland Air Force Base (AFB) TX is preparing an *Environmental Assessment* addressing the *Growdon Gate/Road Relocation and Property Acquisition at Lackland Air Force Base, Texas*. The environmental impact analysis process for this EA is being conducted by the Air Education and Training Command (AETC) and 802 CES in accordance with Council on Environmental Quality regulations pursuant to the requirements of the National Environmental Policy Act (NEPA) of 1969.

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Edward L. Roberson, P.E.
Chief, Asset Optimization
802 CES/CEAO
1555 Gott Street
Lackland AFB TX 78236-5645

Mr. Frederick Land
U.S. Army Corps of Engineers
Regulatory Branch, Permit Section
Attn: CESWF-PER-R P.O. Box 17300
Fort Worth, TX 78612-0300

SUBJECT: Growdon Gate/Road Relocation and Property Acquisition Environmental Assessment at Lackland Air Force Base, Texas

Dear Mr. Land,

The 802d Civil Engineer Squadron (CES) at Lackland Air Force Base (AFB) TX is preparing an *Environmental Assessment* addressing the *Growdon Gate/Road Relocation and Property Acquisition at Lackland Air Force Base, Texas*. The environmental impact analysis process for this EA is being conducted by the Air Education and Training Command (AETC) and 802 CES in accordance with Council on Environmental Quality regulations pursuant to the requirements of the National Environmental Policy Act (NEPA) of 1969.

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Edward L. Roberson, P.E.
Chief, Asset Optimization
802 CES/CEAO
1555 Gott Street
Lackland AFB TX 78236-5645

Mr. Richard Hyde
Deputy Director
TCEQ
Office of Permitting and Registration
MC 122
P.O. Box 13087
Austin, TX 78711-3087

SUBJECT: Growdon Gate/Road Relocation and Property Acquisition Environmental Assessment at Lackland Air Force Base, Texas

Dear Mr. Hyde,

The 802d Civil Engineer Squadron (CES) at Lackland Air Force Base (AFB) TX is preparing an *Environmental Assessment* addressing the *Growdon Gate/Road Relocation and Property Acquisition at Lackland Air Force Base, Texas*. The environmental impact analysis process for this EA is being conducted by the Air Education and Training Command (AETC) and 802 CES in accordance with Council on Environmental Quality regulations pursuant to the requirements of the National Environmental Policy Act (NEPA) of 1969.

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30 APR 2012

Edward L. Roberson, P.E.
Chief, Asset Optimization
802 CES/CEAO
1555 Gott Street
Lackland AFB TX 78236-5645

Mr. F. Lawrence Oaks
State Historical Commision
State Historic Preservation Office
P.O Box 12276
Austin, TX 78111-2276

SUBJECT: Growdon Gate/Road Relocation and Property Acquisition Environmental Assessment at Lackland Air Force Base, Texas

Dear Mr. Oaks,

The 802d Civil Engineer Squadron (CES) at Lackland Air Force Base (AFB) TX is preparing an *Environmental Assessment* addressing the *Growdon Gate/Road Relocation and Property Acquisition at Lackland Air Force Base, Texas*. The environmental impact analysis process for this EA is being conducted by the Air Education and Training Command (AETC) and 802 CES in accordance with Council on Environmental Quality regulations pursuant to the requirements of the National Environmental Policy Act (NEPA) of 1969.

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Edward L. Roberson, P.E.
Chief, Asset Optimization
802 CES/CEAO
1555 Gott Street
Lackland AFB TX 78236-5645

Ms. Denise Francis
Single Point of Contact
TRACs
P.O. Box 12428
Room 441-A
Austin, TX 78711-2428

SUBJECT: Growdon Gate/Road Relocation and Property Acquisition Environmental Assessment at Lackland Air Force Base, Texas

Dear Ms. Francis,

The 802d Civil Engineer Squadron (CES) at Lackland Air Force Base (AFB) TX is preparing an *Environmental Assessment* addressing the *Growdon Gate/Road Relocation and Property Acquisition at Lackland Air Force Base, Texas*. The environmental impact analysis process for this EA is being conducted by the Air Education and Training Command (AETC) and 802 CES in accordance with Council on Environmental Quality regulations pursuant to the requirements of the National Environmental Policy Act (NEPA) of 1969.

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30 APR 2012

Edward L. Roberson, P.E.
Chief, Asset Optimization
802 CES/CEAO
1555 Gott Street
Lackland AFB TX 78236-5645

Mr. Kyle Mills
FEMA
800 North Loop 288
Denton, TX 76209

SUBJECT: Growdon Gate/Road Relocation and Property Acquisition Environmental Assessment at Lackland Air Force Base, Texas

Dear Mr. Mills,

The 802d Civil Engineer Squadron (CES) at Lackland Air Force Base (AFB) TX is preparing an *Environmental Assessment* addressing the *Growdon Gate/Road Relocation and Property Acquisition at Lackland Air Force Base, Texas*. The environmental impact analysis process for this EA is being conducted by the Air Education and Training Command (AETC) and 802 CES in accordance with Council on Environmental Quality regulations pursuant to the requirements of the National Environmental Policy Act (NEPA) of 1969.

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Edward L. Roberson, P.E.
Chief, Asset Optimization
802 CES/CEAO
1555 Gott Street
Lackland AFB TX 78236-5645

Ms. Tiffany Pickens
Community Relations Coordinator
AACOG
8700 Tesoro Drive, Suite 700
San Antonio, TX 78217-6228

SUBJECT: Growdon Gate/Road Relocation and Property Acquisition Environmental Assessment at Lackland Air Force Base, Texas

Dear Ms. Pickens,

The 802d Civil Engineer Squadron (CES) at Lackland Air Force Base (AFB) TX is preparing an *Environmental Assessment* addressing the *Growdon Gate/Road Relocation and Property Acquisition at Lackland Air Force Base, Texas*. The environmental impact analysis process for this EA is being conducted by the Air Education and Training Command (AETC) and 802 CES in accordance with Council on Environmental Quality regulations pursuant to the requirements of the National Environmental Policy Act (NEPA) of 1969.

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Chief, Asset Optimization
802 CES/CEAO
1555 Gott Street
Lackland AFB TX 78236-5645

Mr. David Sager
Chief
TPWD
Ecosystem/Habitat Assessment Branch
4200 Smith School Road
Austin, TX 78744-3291

SUBJECT: Growdon Gate/Road Relocation and Property Acquisition Environmental Assessment at Lackland Air Force Base, Texas

Dear Mr. Sager,

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resulting from the current configuration. The relocation would help reduce conflicts between commercial traffic at the existing Growdon Gate and traffic related to the 433rd Airlift Wing's mission-critical training operations. Additionally, the upgrade and relocation of Growdon Gate is needed to meet the Unified Facilities Criteria, to provide efficient application of force protection measures, and to provide an increased level of security at the entry control point.

The EA will analyze the potential environmental effects at Lackland AFB associated with land acquisition, construction and operation of facilities and infrastructure, and facility demolition. A No-action Alternative is also examined that does not involve acquisition of any property or the relocation and upgrade of Growdon Gate and Road.

In accordance with Executive Order 12372, *Intergovernmental Review of Federal Programs*, we request your participation in the NEPA process by providing comments on the Proposed Action and any potential environmental consequences that might concern you. To facilitate cumulative impact analysis, we would appreciate identification of major projects in the vicinity that may contribute to cumulative effects. Please provide written comments or information at your earliest convenience but no later than 30 days from the date of this letter. We have also attached a listing of federal, state, and local agencies that have been contacted. If there are additional agencies that you feel should review and comment on the proposed activities, please include them in your distribution of this letter and the attachments. When complete, we will mail a copy of the Draft EA and the proposed Finding of No Significant Impact, if applicable, for your review.

Please address your questions or comments on the DOPAA by mail to Mr. Andrew Riley, P.E., 802 CES/CEAOP, 1555 Gott Street, Lackland AFB, Texas 78236-5645.

Sincerely

EDWARD L. ROBERSON, P.E.

Attachments:

1. Figure showing location of Proposed Action
2. Distribution List

DEPARTMENT OF THE AIR FORCE
502D AIR BASE WING
JOINT BASE SAN ANTONIO

30 APR 2012

Edward L. Roberson, P.E.
Chief, Asset Optimization
802 CES/CEAO
1555 Gott Street
Lackland AFB TX 78236-5645

Mr. Nefi Garza, P.E., CFM
Assistant Director of Public Works/FPA
City of San Antonio
P.O. Box 839966
San Antonio, TX 78283

SUBJECT: Growdon Gate/Road Relocation and Property Acquisition Environmental Assessment at Lackland Air Force Base, Texas

Dear Mr. Garza,

The 802d Civil Engineer Squadron (CES) at Lackland Air Force Base (AFB) TX is preparing an *Environmental Assessment* addressing the *Growdon Gate/Road Relocation and Property Acquisition at Lackland Air Force Base, Texas*. The environmental impact analysis process for this EA is being conducted by the Air Education and Training Command (AETC) and 802 CES in accordance with Council on Environmental Quality regulations pursuant to the requirements of the National Environmental Policy Act (NEPA) of 1969.

This EA assesses potential environmental impacts of acquiring approximately 232 acres of property and relocating the Growdon Road Commercial Vehicle Inspection Area and Entry Control Point (also known as Growdon Gate) and Growdon Road from their current location on Lackland AFB, Texas. The attached figure shows the location of the Proposed Action. Lackland AFB has a long range master plan, known as the "Go West" Plan, under which missions currently at Port San Antonio (PSA) immediately east of Lackland AFB would relocate to Lackland AFB proper over a 40 year period. At the present time, the "Go West" Plan has three independent components: (1) constructing a new entry control point and connecting road, (2) relocating airfield operations from PSA property to the west side of the runway, and (3) relocating administrative and warehouse space from PSA to Lackland AFB property. Because all three components are located in the same geographical area, this proposal to implement the first component includes acquisition of the land for all three components. Thus, this EA analyzes the first component and the entire land acquisition.

The upgrade and relocation of Growdon Gate and Road are needed to allow for more efficient and effective screening of commercial vehicles to avoid congestion and extended wait times resulting from the current configuration. The relocation would help reduce conflicts between

commercial traffic at the existing Growdon Gate and traffic related to the 433rd Airlift Wing's mission-critical training operations. Additionally, the upgrade and relocation of Growdon Gate is needed to meet the Unified Facilities Criteria, to provide efficient application of force protection measures, and to provide an increased level of security at the entry control point.

The EA will analyze the potential environmental effects at Lackland AFB associated with land acquisition, construction and operation of facilities and infrastructure, and facility demolition. A No-action Alternative is also examined that does not involve acquisition of any property or the relocation and upgrade of Growdon Gate and Road.

In accordance with Executive Order 12372, *Intergovernmental Review of Federal Programs*, we request your participation in the NEPA process by providing comments on the Proposed Action and any potential environmental consequences that might concern you. To facilitate cumulative impact analysis, we would appreciate identification of major projects in the vicinity that may contribute to cumulative effects. Please provide written comments or information at your earliest convenience but no later than 30 days from the date of this letter. We have also attached a listing of federal, state, and local agencies that have been contacted. If there are additional agencies that you feel should review and comment on the proposed activities, please include them in your distribution of this letter and the attachments. When complete, we will mail a copy of the Draft EA and the proposed Finding of No Significant Impact, if applicable, for your review.

Please address your questions or comments on the DOPAA by mail to Mr. Andrew Riley, P.E., 802 CES/CEAOP, 1555 Gott Street, Lackland AFB, Texas 78236-5645.

Sincerely

EDWARD L. ROBERSON, P.E.

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DEPARTMENT OF THE AIR FORCE
502D AIR BASE WING
JOINT BASE SAN ANTONIO

30 APR 2012

Edward L. Roberson, P.E.
Chief, Asset Optimization
802 CES/CEAO
1555 Gott Street
Lackland AFB TX 78236-5645

Mr. James Henderson
City of San Antonio
P.O. Box 839966
San Antonio, TX 78283

SUBJECT: Growdon Gate/Road Relocation and Property Acquisition Environmental Assessment at Lackland Air Force Base, Texas

Dear Mr. Henderson,

The 802d Civil Engineer Squadron (CES) at Lackland Air Force Base (AFB) TX is preparing an *Environmental Assessment* addressing the *Growdon Gate/Road Relocation and Property Acquisition at Lackland Air Force Base, Texas*. The environmental impact analysis process for this EA is being conducted by the Air Education and Training Command (AETC) and 802 CES in accordance with Council on Environmental Quality regulations pursuant to the requirements of the National Environmental Policy Act (NEPA) of 1969.

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Sincerely

Edward L Roberson

EDWARD L. ROBERSON, P.E.

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1. Figure showing location of Proposed Action
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DEPARTMENT OF THE AIR FORCE
502D AIR BASE WING
JOINT BASE SAN ANTONIO

30 APR 2012

Edward L. Roberson, P.E.
Chief, Asset Optimization
802 CES/CEAO
1555 Gott Street
Lackland AFB TX 78236-5645

Mr. John Cantu
Environmental Manager
City of San Antonio
Capital Improvements Management Services Dept.
111 E. Soledad, Suite 675
San Antonio, TX 78205

SUBJECT: Growdon Gate/Road Relocation and Property Acquisition Environmental Assessment at Lackland Air Force Base, Texas

Dear Mr. Cantu,

The 802d Civil Engineer Squadron (CES) at Lackland Air Force Base (AFB) TX is preparing an *Environmental Assessment* addressing the *Growdon Gate/Road Relocation and Property Acquisition at Lackland Air Force Base, Texas*. The environmental impact analysis process for this EA is being conducted by the Air Education and Training Command (AETC) and 802 CES in accordance with Council on Environmental Quality regulations pursuant to the requirements of the National Environmental Policy Act (NEPA) of 1969.

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Please address your questions or comments on the DOPAA by mail to Mr. Andrew Riley, P.E., 802 CES/CEAOP, 1555 Gott Street, Lackland AFB, Texas 78236-5645.

Sincerely

Edward L Roberson

EDWARD L. ROBERSON, P.E.

Attachments:
1. Figure showing location of Proposed Action
2. Distribution List

General Scoping Letter Attachments

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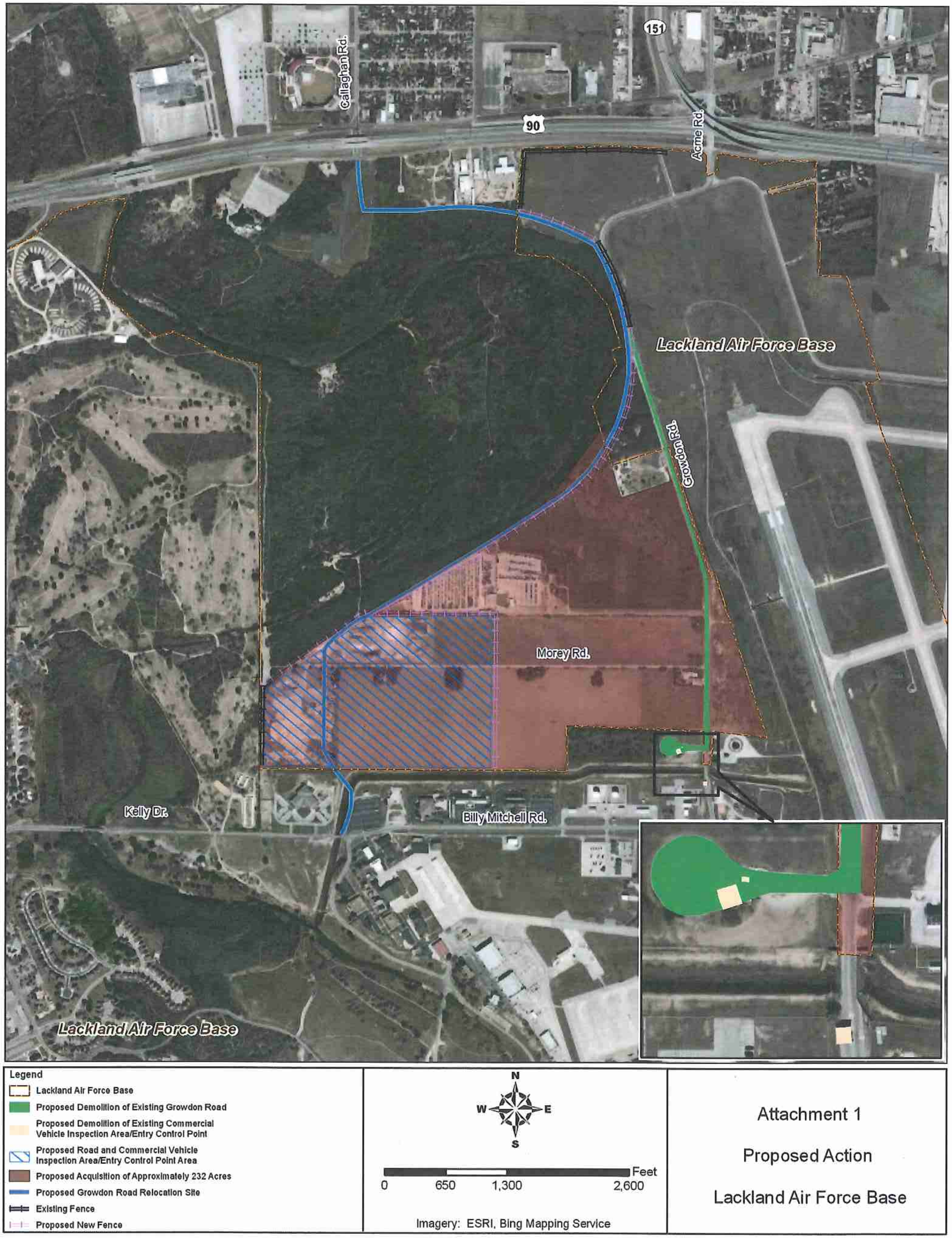

Attachment 1

Proposed Action

Lackland Air Force Base

Attachment 2 - Distribution List
Growdon Gate and Road Relocation Environmental Assessment
Lackland Air Force Base, Texas
8 February 2012

General List

Agency	Department	Title	Title-1	Name	Last Name	Address	City	State	Zip Code
USEPA	Region 6	Administrator	Ms.	Lisa	Jackson	1445 Ross Avenue, Suite 1200	Dallas	TX	75202
U.S. Fish and Wildlife Service		Field Supervisor	Mr.	David	Frederick	10711 Burnet Road, Suite 200	Austin	TX	78758-4460
U.S. Army Corps of Engineers	Regulatory Branch, Permit Section		Mr.	Frederick	Land	Attn: CESWF-PER-R P.O. Box 17300	Fort Worth	TX	78612-0300
TCEQ	Office of Permitting and Registration	Deputy Director	Mr.	Richard	Hyde	MC 122 P.O. Box 13087	Austin	TX	78711-3087
State Historical Commision	State Historic Preservation Office		Mr.	F. Lawrence	Oaks	P.O Box 12276	Austin	TX	78111-2276
TRACs		Single Point of Contact	Ms.	Denise	Francis	P.O. Box 12428 Room 441-A	Austin	TX	78711-2428
FEMA			Mr.	Kyle	Mills	800 North Loop 288	Denton	TX	76209
AACOG		Community Relations Coordinator	Ms.	Tiffany	Pickens	8700 Tesoro Drive, Suite 700	San Antonio	TX	78217-6228
TPWD	Ecosystem/Habitat Assessment Branch	Chief	Mr.	David	Sager	4200 Smith School Road	Austin	TX	78744-3291
City of San Antonio		Assistant Director of Public Works/FPA	Mr.	Nefi	Garza, P.E., CFM	P.O. Box 839966	San Antonio	TX	78283
City of San Antonio			Mr.	James	Henderson	P.O. Box 839966	San Antonio	TX	78283
City of San Antonio	Capital Improvements Management Services Dept.	Environmental Manager	Mr.	John	Cantu	111 E. Soledad, Suite 675	San Antonio	TX	78205

Attachment 2 - Distribution List
Growdon Gate and Road Relocation Environmental Assessment
Lackland Air Force Base, Texas
8 February 2012

Tribal List

Agency	Title	Title-1	Name	Last Name	Address	City	State	Zip Code
Comanche Tribe	Chairman	Mr.	Wallace	Coffee	P.O. Box 908	Lawton	OK	73502
Mescalero Apache and Affiliated Tribes	President	Mr.	Mark	Chino	P.O. Box 227	Mescalero	NM	88340
Wichita and Affiliated Tribes	President	Mr.	Gary	McAdams	P.O. Box 729	Andarko	OK	73005
Tonkawa Tribe	President	Mr.	Donald	Patterson	1 Rush Buffalo Road	Tonkawa	OK	74653

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Signed Tribal Scoping Letter

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DEPARTMENT OF THE AIR FORCE
502D AIR BASE WING
JOINT BASE SAN ANTONIO

MAY 02 2012

Brigadier General Theresa C. Carter
502 ABW/CC
2080 Wilson Way
Joint Base San Antonio
Fort Sam Houston Texas 78234

Mr. Johnny Wauqua
Chairman
Comanche Tribe
P.O. Box 908
Lawton Oklahoma 73502

Dear Mr. Wauqua

The U.S. Air Force's Air Education and Training Command (AETC) and Joint Base San Antonio-Lackland are preparing an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA). This EA assesses potential environmental impacts of acquiring approximately 232 acres of property and relocating the Growdon Road Commercial Vehicle Inspection Area and Entry Control Point (also known as Growdon Gate) and Growdon Road from their current location on Joint Base San Antonio-Lackland, Texas. Joint Base San Antonio-Lackland has a long range master plan, known as the "Go West" Plan, under which missions currently at Port San Antonio (PSA) immediately east of Joint Base San Antonio-Lackland would relocate to Joint Base San Antonio-Lackland proper over a 40 year period. At the present time, the "Go West" Plan has three independent components: (1) constructing a new entry control point and connecting road, (2) relocating airfield operations from PSA property to the west side of the runway, and (3) relocating administrative and warehouse space from PSA to Joint Base San Antonio-Lackland property. Because all three components are located in the same geographical area, this proposal to implement the first component includes acquisition of the land for all three components. Thus, this EA analyzes the first component and the entire land acquisition.

The upgrade and relocation of Growdon Gate and Road are needed to allow for more efficient and effective screening of commercial vehicles to avoid congestion and extended wait times resulting from the current configuration. The relocation would help reduce conflicts between commercial traffic at the existing Growdon Gate and traffic related to the 433rd Airlift Wing's mission-critical training operations. Additionally, the upgrade and relocation of Growdon Gate is needed to meet Unified Facilities Criteria, to provide efficient application of force protection measures, and to provide an increased level of security.

The EA will analyze the potential environmental effects at Joint Base San Antonio-Lackland associated with land acquisition, construction and operation of facilities and infrastructure, and facility demolition. A No-action Alternative is also examined that does not involve acquisition of any property or the relocation and upgrade of Growdon Gate and Road.

Joint Base San Antonio-Lackland desires to initiate consultation with the Comanche Tribe so you can express your comments, concerns, and suggestions. These consultations, conducted pursuant to Section 106 of the National Historic Preservation Act, 36 CFR Part 800, and Executive Order 13175, will provide an excellent opportunity to exchange information, ask questions, and advise Joint Base San Antonio-Lackland of any concerns or suggestions you may have. Please let me know if you would like to meet to discuss this proposal and to plan how our staffs will communicate during the consultations. When complete, we will mail a copy of the Draft EA and Finding of No Significant Impact, if applicable, for your review. This will give you an additional opportunity to provide input.

If your staff has any questions please direct them to Mr. Andrew Riley, P.E., Joint Base San Antonio-Lackland NEPA Project Manager, at (210) 671-5339, e-mail at andrew.riley@us.af.mil, or regular mail at 802 CES/CEAOP, 1555 Gott St, Lackland Air Force Base Texas 78236-5645.

I appreciate your interest in consulting with Joint Base San Antonio-Lackland and look forward to working with the Comanche Tribe in the future.

Sincerely

THERESA C. CARTER
Brigadier General, USAF
Commander

Attachment:
Figure showing location of Proposed Action

DEPARTMENT OF THE AIR FORCE
502D AIR BASE WING
JOINT BASE SAN ANTONIO

MAY 02 2012

Brigadier General Theresa C. Carter
502 ABW/CC
2080 Wilson Way
Joint Base San Antonio
Fort Sam Houston Texas 78234

Mr. Mark Chino
President
Mescalero Apache and Affiliated Tribes
P.O. Box 227
Mescalero New Mexico 88340

Dear Mr. Chino

The U.S. Air Force's Air Education and Training Command (AETC) and Joint Base San Antonio-Lackland are preparing an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA). This EA assesses potential environmental impacts of acquiring approximately 232 acres of property and relocating the Growdon Road Commercial Vehicle Inspection Area and Entry Control Point (also known as Growdon Gate) and Growdon Road from their current location on Joint Base San Antonio-Lackland, Texas. Joint Base San Antonio-Lackland has a long range master plan, known as the "Go West" Plan, under which missions currently at Port San Antonio (PSA) immediately east of Joint Base San Antonio-Lackland would relocate to Joint Base San Antonio-Lackland proper over a 40 year period. At the present time, the "Go West" Plan has three independent components: (1) constructing a new entry control point and connecting road, (2) relocating airfield operations from PSA property to the west side of the runway, and (3) relocating administrative and warehouse space from PSA to Joint Base San Antonio-Lackland property. Because all three components are located in the same geographical area, this proposal to implement the first component includes acquisition of the land for all three components. Thus, this EA analyzes the first component and the entire land acquisition.

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The EA will analyze the potential environmental effects at Joint Base San Antonio-Lackland associated with land acquisition, construction and operation of facilities and infrastructure, and facility demolition. A No-action Alternative is also examined that does not involve acquisition of any property or the relocation and upgrade of Growdon Gate and Road.

Joint Base San Antonio-Lackland desires to initiate consultation with the Mescalero Apache and Affiliated Tribes so you can express your comments, concerns, and suggestions. These consultations, conducted pursuant to Section 106 of the National Historic Preservation Act, 36 CFR Part 800, and Executive Order 13175, will provide an excellent opportunity to exchange information, ask questions, and advise Joint Base San Antonio-Lackland of any concerns or suggestions you may have. Please let me know if you would like to meet to discuss this proposal and to plan how our staffs will communicate during the consultations. When complete, we will mail a copy of the Draft EA and Finding of No Significant Impact, if applicable, for your review. This will give you an additional opportunity to provide input.

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I appreciate your interest in consulting with Joint Base San Antonio-Lackland and look forward to working with the Mescalero Apache and Affiliated Tribes in the future.

Sincerely

THERESA C. CARTER
Brigadier General, USAF
Commander

Attachment:
Figure showing location of Proposed Action

DEPARTMENT OF THE AIR FORCE
502D AIR BASE WING
JOINT BASE SAN ANTONIO

MAY 02 2012

Brigadier General Theresa C. Carter
502 ABW/CC
2080 Wilson Way
Joint Base San Antonio
Fort Sam Houston Texas 78234

Mr. Donald Patterson
President
Tonkawa Tribe
1 Rush Buffalo Road
Tonkawa Oklahoma 74653

Dear Mr. Patterson

The U.S. Air Force's Air Education and Training Command (AETC) and Joint Base San Antonio-Lackland are preparing an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA). This EA assesses potential environmental impacts of acquiring approximately 232 acres of property and relocating the Growdon Road Commercial Vehicle Inspection Area and Entry Control Point (also known as Growdon Gate) and Growdon Road from their current location on Joint Base San Antonio-Lackland, Texas. Joint Base San Antonio-Lackland has a long range master plan, known as the "Go West" Plan, under which missions currently at Port San Antonio (PSA) immediately east of Joint Base San Antonio-Lackland would relocate to Joint Base San Antonio-Lackland proper over a 40 year period. At the present time, the "Go West" Plan has three independent components: (1) constructing a new entry control point and connecting road, (2) relocating airfield operations from PSA property to the west side of the runway, and (3) relocating administrative and warehouse space from PSA to Joint Base San Antonio-Lackland property. Because all three components are located in the same geographical area, this proposal to implement the first component includes acquisition of the land for all three components. Thus, this EA analyzes the first component and the entire land acquisition.

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Joint Base San Antonio-Lackland desires to initiate consultation with the Tonkawa Tribe so you can express your comments, concerns, and suggestions. These consultations, conducted pursuant to Section 106 of the National Historic Preservation Act, 36 CFR Part 800, and Executive Order 13175, will provide an excellent opportunity to exchange information, ask questions, and advise Joint Base San Antonio-Lackland of any concerns or suggestions you may have. Please let me know if you would like to meet to discuss this proposal and to plan how our staffs will communicate during the consultations. When complete, we will mail a copy of the Draft EA and Finding of No Significant Impact, if applicable, for your review. This will give you an additional opportunity to provide input.

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I appreciate your interest in consulting with Joint Base San Antonio-Lackland and look forward to working with the Tonkawa Tribe in the future.

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THERESA C. CARTER
Brigadier General, USAF
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Figure showing location of Proposed Action

DEPARTMENT OF THE AIR FORCE
502D AIR BASE WING
JOINT BASE SAN ANTONIO

MAY 02 2012

Brigadier General Theresa C. Carter
502 ABW/CC
2080 Wilson Way
Joint Base San Antonio
Fort Sam Houston Texas 78234

Mr. Leslie Standing
President
Wichita and Affiliated Tribes
P.O. Box 729
Andarko Oklahoma 73005

Dear Mr. Standing

The U.S. Air Force's Air Education and Training Command (AETC) and Joint Base San Antonio-Lackland are preparing an Environmental Assessment (EA) under the National Environmental Policy Act (NEPA). This EA assesses potential environmental impacts of acquiring approximately 232 acres of property and relocating the Growdon Road Commercial Vehicle Inspection Area and Entry Control Point (also known as Growdon Gate) and Growdon Road from their current location on Joint Base San Antonio-Lackland, Texas. Joint Base San Antonio-Lackland has a long range master plan, known as the "Go West" Plan, under which missions currently at Port San Antonio (PSA) immediately east of Joint Base San Antonio-Lackland would relocate to Joint Base San Antonio-Lackland proper over a 40 year period. At the present time, the "Go West" Plan has three independent components: (1) constructing a new entry control point and connecting road, (2) relocating airfield operations from PSA property to the west side of the runway, and (3) relocating administrative and warehouse space from PSA to Joint Base San Antonio-Lackland property. Because all three components are located in the same geographical area, this proposal to implement the first component includes acquisition of the land for all three components. Thus, this EA analyzes the first component and the entire land acquisition.

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Joint Base San Antonio-Lackland desires to initiate consultation with the Wichita and Affiliated Tribes so you can express your comments, concerns, and suggestions. These consultations, conducted pursuant to Section 106 of the National Historic Preservation Act, 36 CFR Part 800, and Executive Order 13175, will provide an excellent opportunity to exchange information, ask questions, and advise Joint Base San Antonio-Lackland of any concerns or suggestions you may have. Please let me know if you would like to meet to discuss this proposal and to plan how our staffs will communicate during the consultations. When complete, we will mail a copy of the Draft EA and Finding of No Significant Impact, if applicable, for your review. This will give you an additional opportunity to provide input.

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I appreciate your interest in consulting with Joint Base San Antonio-Lackland and look forward to working with the Wichita and Affiliated Tribes in the future.

Sincerely

THERESA C. CARTER
Brigadier General, USAF
Commander

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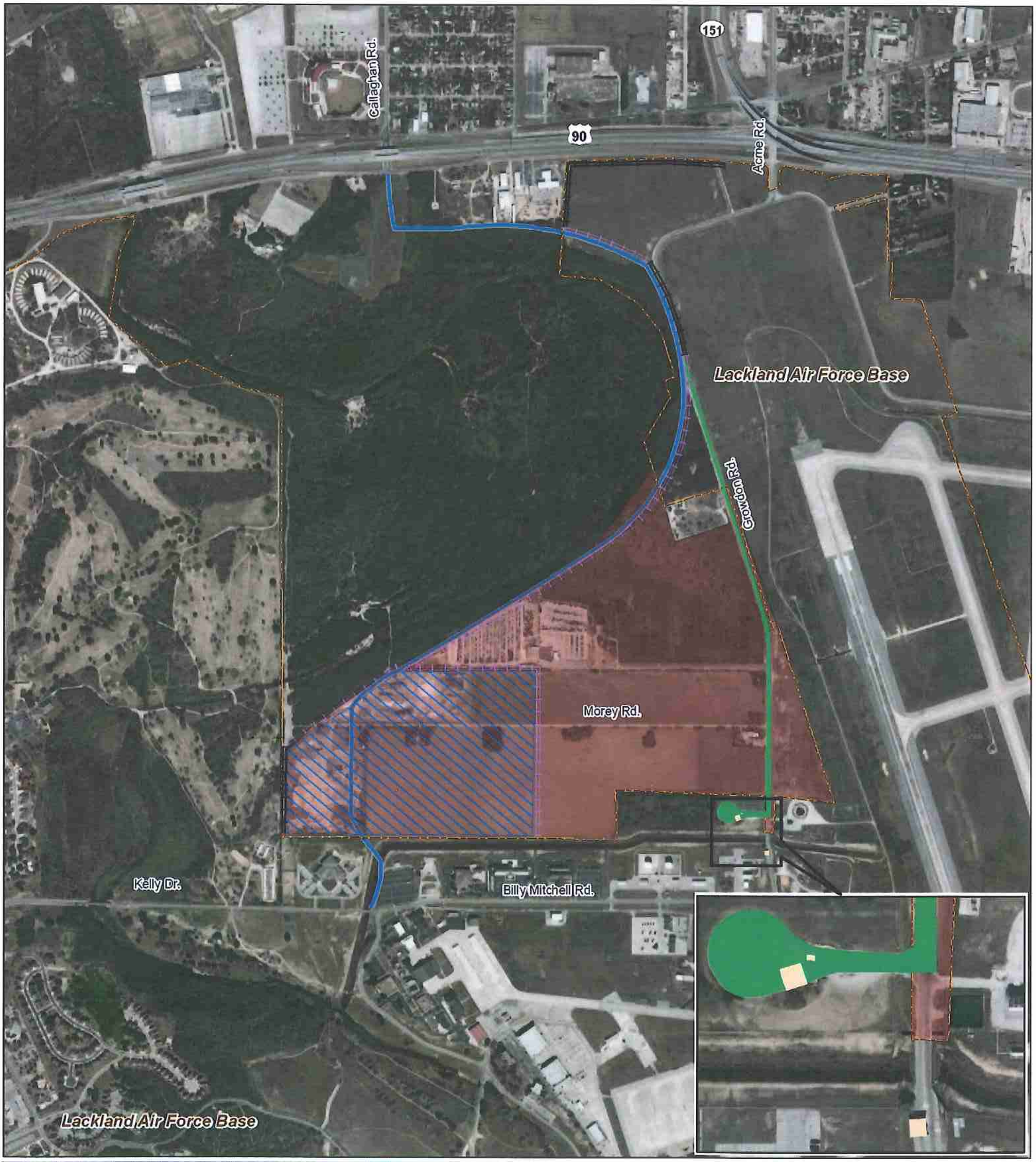
Figure showing location of Proposed Action

Tribal Scoping Letter Attachment



Legend
- Lackland Air Force Base
- Proposed Demolition of Existing Growdon Road
- Proposed Demolition of Existing Commercial Vehicle Inspection Area/Entry Control Point
- Proposed Road and Commercial Vehicle Inspection Area/Entry Control Point Area
- Proposed Acquisition of Approximately 232 Acres
- Proposed Growdon Road Relocation Site
- Existing Fence
- Proposed New Fence

N W E S

0 650 1,300 2,600 Feet

Imagery: ESRI, Bing Mapping Service

Attachment 1

Proposed Action

Lackland Air Force Base

Final IICEP Scoping Mailing List

Scoping Mailing List
Growdon Gate/Road Relocation EA
Joint Base San Antonio - Lackland, Texas
3 May 2012

Agency	Department	Title	Name	Last Name	Address	City	State	Zip Code
USEPA	Region 6	Administrator	Lisa	Jackson	1445 Ross Avenue, Suite 1200	Dallas	TX	75202
U.S. Fish and Wildlife Service		Field Supervisor	David	Frederick	10711 Burnet Road, Suite 200	Austin	TX	78758-4460
U.S. Army Corps of Engineers	Regulatory Branch, Permit Section		Stephen	Brooks	Attn: CESWF-PER-R P.O. Box 17300	Fort Worth	TX	76102-0300
TCEQ	Office of Permitting and Registration	Deputy Director	Richard	Hyde	MC 122 P.O. Box 13087	Austin	TX	78711-3087
State Historical Commision	State Historic Preservation Office		F. Lawrence	Oaks	P.O Box 12276	Austin	TX	78711-2276
TRACs		Single Point of Contact	Denise	Francis	P.O. Box 12428 Room 441-A	Austin	TX	78711-2428
FEMA			Kyle	Mills	800 North Loop 288	Denton	TX	76209
AACOG		Community Relations Coordinator	Tiffany	Pickens	8700 Tesoro Drive, Suite 700	San Antonio	TX	78217-6228
TPWD	Ecosystem/Habitat Assessment Branch	Chief	David	Sager	4200 Smith School Road	Austin	TX	78744-3291
ComancheTribe		Chairman	Johnny	Wauqua	P.O. Box 908	Lawton	OK	73502
Mescalero Apache and Affiliated Tribes		President	Mark	Chino	P.O. Box 227	Mescalero	NM	88340
Wichita and Affiliated Tribes		President	Leslie	Standing	P.O. Box 729	Andarko	OK	73005
Tonkawa Tribe		President	Donald	Patterson	1 Rush Buffalo Road	Tonkawa	OK	74653
City of San Antonio		Assistant Director of Public Works/FPA	Nefi	Garza, P.E., CFM	P.O. Box 839966	San Antonio	TX	78283
City of San Antonio			James	Henderson	P.O. Box 839966	San Antonio	TX	78283
City of San Antonio	Capital Improvements Management Services Dept.	Environmental Manager	John	Cantu	111 E. Soledad, Suite 675	San Antonio	TX	78205

IICEP Scoping Responses

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

May 14, 2012

Mr. Andrew Riley, PE
DOPAA
802 CES/CEAOP
1555 Gott Street
Lackland AFB, TX 78236-5645

Re: TCEQ Grant and Texas Review and Comment System (TRACS) #2012-199, City of Lackland Air Force Base, Bexar County - Growdon Gate/Road Relocation and Property Acquisition Environmental Assessment at Lackland AFB, Texas

Dear Mr. Riley:

The Texas Commission on Environmental Quality (TCEQ) has reviewed the above-referenced project and offers following comments:

A review of the project for General Conformity impact in accordance with 40 CFR Part 93 and Title 30, Texas Administrative Code § 101.30 indicates that the proposed action is located in the City of Lackland Air Force Base, Bexar County, which is currently unclassified or in attainment of the National Ambient Air Quality Standards for all six criteria air pollutants. Therefore, General Conformity does not apply.

Although any demolition, construction, rehabilitation or repair project will produce dust and particulate emissions, these actions should pose no significant impact upon air quality standards. Any minimal dust and particulate emissions should be easily controlled by the construction contractors using standard dust mitigation techniques.

We recommend the environmental assessment address actions that will be taken to prevent surface and groundwater contamination.

Thank you for the opportunity to review this project. If you have any questions, please contact Ms. Janie Roman at (512) 239-0604 or Janie.roman@tceq.texas.gov.

Sincerely,

Jim Harrison, Director
Intergovernmental Relations Division

DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P.O. BOX 17300
FORT WORTH, TEXAS 76102-0300

REPLY TO
ATTENTION OF

May 21, 2012

Planning, Environmental, and Regulatory Division
Regulatory Branch

SUBJECT: Project Number SWF-2012-00236, Growdon Gate/Road Relocaton and Property Acquisition

Edward Roberson, P.E.
Chief, Asset Optimization
802 CES/CEAO
1555 Gott Street
Lackland AFB, TX 78236-5645

Dear Mr. Roberson, P.E.:

Thank you for your letter received May 14, 2012 concerning a proposal by 802d Civil Engineer Squadron to acquire approximately 232 acres of property and relocate the Growdon Road Commercial Vehicle Inspection Area and Entry Control Point and Growdon Road located on Lackland Air Force Base, TX. This project has been assigned Project Number SWF-2012-00236. Please include this number in all future correspondence concerning this project.

Mr. Frederick Land has been assigned as the regulatory project manager for your request and will be evaluating it as expeditiously as possible.

You may be contacted for additional information about your request. For your information, please reference the Fort Worth District Regulatory Branch homepage at http://www.swf.usace.army.mil/regulatory and particularly guidance on submittals at http://www.swf.usace.army.mil/pubdata/environ/regulatory/introduction/submital.pdf, and mitigation at http://www.usace.army.mil/CECW/Pages/final_cmr.aspx that may help you supplement your current request or prepare future requests.

If you have any questions about the evaluation of your submittal or would like to request a copy of one of the documents referenced above, please contact Mr. Frederick Land at the address above or telephone (817) 886-1729 and refer to your assigned project number. Please note that it is unlawful to start work without a Department of the Army permit if one is required.

Please help the Regulatory Program improve its service by completing the survey on the following website: http://per2.nwp.usace.army.mil/survey.html.

Stephen L Brooks
Chief, Regulatory Branch

U. S. Department of Homeland Security
FEMA Region 6
800 North Loop 288
Denton, TX 76209-3698

FEMA

FEDERAL EMERGENCY MANAGEMENT AGENCY
REGION VI
MITIGATION DIVISION

NOTICE REVIEW/ENVIRONMENTAL CONSULTATION

☐ We have no comments to offer. ☒ We offer the following comments:

WE WOULD RECOMMEND THAT THE LOCAL & COUNTY FLOODPLAIN ADMINISTRATOR, AS WELL AS THE STATE NFIP COORDINATOR BE CONTACTED FOR THE REVIEW AND POSSIBLE PERMIT REQUIREMENTS FOR THIS PROJECT. IF FEDERALLY FUNDED, WE WOULD REQUEST PROJECT TO BE IN COMPLIANCE WITH EO 11988 & EO 11990.

Nefi Garza, PE
Assistant Director of Public Work
City of San Antonio
P. O. Box 839966
San Antonio, TX 78283
nefi.garza@sanantonio.gov
210-207-7785

Diane Bartlett
FPA
Bexar County
233 North Pecos Street, Suite 420
San Antonio, TX 78207
dbartlett@bexar.org
210-335-3843

Michael Segner, CFM
NFIP State Coordinator
Texas Water Development Board
P. O. Box 13231
Austin, Texas 78711-3231

REVIEWER:

Mayra G. Diaz
Floodplain Management and Insurance Branch
Mitigation Division
(940) 898-5541 DATE: June 18, 2012

DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P.O. BOX 17300
FORT WORTH, TEXAS 76102-0300

REPLY TO
ATTENTION OF

May 21, 2012

Planning, Environmental, and Regulatory Division
Regulatory Branch

SUBJECT: Project Number SWF-2012-00236, Growdon Gate/Road Relocaton and Property Acquisition

Edward Roberson, P.E.
Chief, Asset Optimization
802 CES/CEAO
1555 Gott Street
Lackland AFB, TX 78236-5645

Dear Mr. Roberson, P.E.:

Thank you for your letter received May 14, 2012 concerning a proposal by 802d Civil Engineer Squadron to acquire approximately 232 acres of property and relocate the Growdon Road Commercial Vehicle Inspection Area and Entry Control Point and Growdon Road located on Lackland Air Force Base, TX. This project has been assigned Project Number SWF-2012-00236. Please include this number in all future correspondence concerning this project.

Mr. Frederick Land has been assigned as the regulatory project manager for your request and will be evaluating it as expeditiously as possible.

You may be contacted for additional information about your request. For your information, please reference the Fort Worth District Regulatory Branch homepage at http://www.swf.usace.army.mil/regulatory and particularly guidance on submittals at http://www.swf.usace.army.mil/pubdata/environ/regulatory/introduction/submital.pdf, and mitigation at http://www.usace.army.mil/CECW/Pages/final_cmr.aspx that may help you supplement your current request or prepare future requests.

If you have any questions about the evaluation of your submittal or would like to request a copy of one of the documents referenced above, please contact Mr. Frederick Land at the address above or telephone (817) 886-1729 and refer to your assigned project number. Please note that it is unlawful to start work without a Department of the Army permit if one is required.

Please help the Regulatory Program improve its service by completing the survey on the following website: http://per2.nwp.usace.army.mil/survey.html.

Stephen L Brooks
Chief, Regulatory Branch

DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P.O. BOX 17300
FORT WORTH, TEXAS 76102-0300

REPLY TO
ATTENTION OF

July 30, 2012

Planning, Environmental, and Regulatory Division
Regulatory Branch

SUBJECT: Project Number SWF-2012-00236, Growdon Gate/Road Relocation and Property Acquisition

Mr. Edward Roberson, P.E.
Chief, Asset Optimization
802 CES/CEAO
1555 Gott Street
Lackland Air Force Base, Texas 78236-5645

Dear Mr. Roberson:

Thank you for your letter received May 14, 2012, concerning the proposal by the United States Air Force to relocate Growdon Road at Lackland Air Force Base, near the city of San Antonio, Bexar County, Texas. This project has been assigned Project Number SWF-2012-00236. Please include this number in all future correspondence concerning this project.

Under Section 404 of the Clean Water Act the U. S. Army Corps of Engineers (USACE) regulates the discharge of dredged and fill material into waters of the United States, including wetlands. USACE responsibility under Section 10 of the Rivers and Harbors Act of 1899 is to regulate any work in, or affecting, navigable waters of the United States. Based on your description of the proposed work, and other information available to us, we have determined this project will involve activities subject to the requirements of Section 404. The USACE based this decision on a preliminary jurisdictional determination that there are waters of the United States within the project site.

We have reviewed the proposal and based on the information provided, it appears the activity may qualify for Nationwide Permit 14 for Linear Transportation Projects. Please review the enclosed nationwide permit concerning the proposed placement of dredged or fill material into waters of the United States. Provided the permittee complies with all the terms and conditions therein, the project may proceed. If the permittee cannot comply with the conditions of the nationwide permit, please reply.

This nationwide permit is valid until March 18, 2017, unless prior to that date the nationwide permit is suspended, revoked, or modified such that the activity would no longer comply with the terms and conditions of the nationwide permit on a regional or national basis. The USACE will issue a public notice announcing the changes when they occur. Furthermore, activities that have commenced, or are under contract to commence, in reliance on a nationwide permit will remain authorized provided the activity is completed within 12 months of the date of the nationwide permit's expiration, modification, or revocation, unless discretionary authority has been exercised on a case-by-case basis to modify, suspend, or revoke the authorization in accordance with 33 CFR 330.4(e) and 33 CFR 330.5(c) or (d). Continued confirmation that an activity complies with the specifications and conditions, and any changes to the nationwide permit, is the responsibility of the permittee.

Thank you for your interest in our nation's water resources. If you have any questions concerning our regulatory program, please refer to our website at http://www.swf.usace.army.mil/regulatory or contact Mr. Eric Dephouse at the address above or telephone 817-886-1820.

Please help the Regulatory Program improve its service by completing the survey on the following website: http://per2.nwp.usace.army.mil/survey.html.

Sincerely,

Stephen L Brooks
Chief, Regulatory Branch

Enclosures

Copy Furnished (Without Enclosures):

SWF-2012-00236 Project File

NATIONWIDE PERMIT 14

Linear Transportation Projects

Effective Date: March 19, 2012

(NWP Final Notice, 77 FR 10184)

Linear Transportation Projects. Activities required for the construction, expansion, modification, or improvement of linear transportation projects (e.g., roads, highways, railways, trails, airport runways, and taxiways) in waters of the United States. For linear transportation projects in non-tidal waters, the discharge cannot cause the loss of greater than 1/2-acre of waters of the United States. For linear transportation projects in tidal waters, the discharge cannot cause the loss of greater than 1/3-acre of waters of the United States. Any stream channel modification, including bank stabilization, is limited to the minimum necessary to construct or protect the linear transportation project; such modifications must be in the immediate vicinity of the project.

This NWP also authorizes temporary structures, fills, and work necessary to construct the linear transportation project. Appropriate measures must be taken to maintain normal downstream flows and minimize flooding to the maximum extent practicable, when temporary structures, work, and discharges, including cofferdams, are necessary for construction activities, access fills, or dewatering of construction sites. Temporary fills must consist of materials, and be placed in a manner, that will not be eroded by expected high flows. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The areas affected by temporary fills must be revegetated, as appropriate.

This NWP cannot be used to authorize non-linear features commonly associated with transportation projects, such as vehicle maintenance or storage buildings, parking lots, train stations, or aircraft hangars.

Notification: The permittee must submit a pre-construction notification to the district engineer prior to commencing the activity if: (1) the loss of waters of the United States exceeds 1/10-acre; or (2) there is a discharge in a special aquatic site, including wetlands. (See general condition 31.) (Sections 10 and 404)

Note: Some discharges for the construction of farm roads or forest roads, or temporary roads for moving mining equipment, may qualify for an exemption under Section 404(f) of the Clean Water Act (see 33 CFR 323.4).

Nationwide Permit General Conditions

Note: To qualify for NWP authorization, the prospective permittee must comply with the following general conditions, as applicable, in addition to any regional or case-specific conditions imposed by the division engineer or district engineer. Prospective permittees should contact the appropriate Corps district office to determine if regional conditions have been imposed on an NWP. Prospective permittees should also contact the appropriate Corps district office to determine the status of Clean Water Act Section 401 water quality certification and/or Coastal Zone Management Act consistency for an NWP. Every person who may wish to obtain permit authorization under one or more NWPs, or who is currently relying on an existing or prior permit authorization under one or more NWPs, has been and is on notice that all of the provisions of 33 CFR §§ 330.1 through 330.6 apply to every NWP authorization. Note especially 33 CFR § 330.5 relating to the modification, suspension, or revocation of any NWP authorization.

1. Navigation. (a) No activity may cause more than a minimal adverse effect on navigation.

(b) Any safety lights and signals prescribed by the U.S. Coast Guard, through regulations or otherwise, must be installed and maintained at the permittee's expense on authorized facilities in navigable waters of the United States.

(c) The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

2. Aquatic Life Movements. No activity may substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water. All permanent and temporary crossings of waterbodies shall be suitably culverted, bridged, or otherwise designed and constructed to maintain low flows to sustain the movement of those aquatic species.

3. Spawning Areas. Activities in spawning areas during spawning seasons must be avoided to the maximum extent practicable. Activities that result in the physical destruction (e.g., through excavation, fill, or downstream smothering by substantial turbidity) of an important spawning area are not authorized.

4. Migratory Bird Breeding Areas. Activities in waters of the United States that serve as breeding areas for migratory birds must be avoided to the maximum extent practicable.

5. Shellfish Beds. No activity may occur in areas of concentrated shellfish populations, unless the activity is directly related to a shellfish harvesting activity authorized by NWPs 4 and 48, or is a shellfish seeding or habitat restoration activity authorized by NWP 27.

6. Suitable Material. No activity may use unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.). Material used for construction or discharged must be free from toxic pollutants in toxic amounts (see Section 307 of the Clean Water Act).

7. Water Supply Intakes. No activity may occur in the proximity of a public water supply intake, except where the activity is for the repair or improvement of public water supply intake structures or adjacent bank stabilization.

8. Adverse Effects From Impoundments. If the activity creates an impoundment of water, adverse effects to the aquatic system due to accelerating the passage of water, and/or restricting its flow must be minimized to the maximum extent practicable.

9. Management of Water Flows. To the maximum extent practicable, the pre-construction course, condition, capacity, and location of open waters must be maintained for each activity,

including stream channelization and storm water management activities, except as provided below. The activity must be constructed to withstand expected high flows. The activity must not restrict or impede the passage of normal or high flows, unless the primary purpose of the activity is to impound water or manage high flows. The activity may alter the pre-construction course, condition, capacity, and location of open waters if it benefits the aquatic environment (e.g., stream restoration or relocation activities).

10. Fills Within 100-Year Floodplains. The activity must comply with applicable FEMA-approved state or local floodplain management requirements.

11. Equipment. Heavy equipment working in wetlands or mudflats must be placed on mats, or other measures must be taken to minimize soil disturbance.

12. Soil Erosion and Sediment Controls. Appropriate soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date. Permittees are encouraged to perform work within waters of the United States during periods of low-flow or no-flow.

13. Removal of Temporary Fills. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The affected areas must be revegetated, as appropriate.

14. Proper Maintenance. Any authorized structure or fill shall be properly maintained, including maintenance to ensure public safety and compliance with applicable NWP general conditions, as well as any activity-specific conditions added by the district engineer to an NWP authorization.

15. Single and Complete Project. The activity must be a single and complete project. The same NWP cannot be used more than once for the same single and complete project.

16. Wild and Scenic Rivers. No activity may occur in a component of the National Wild and Scenic River System, or in a river officially designated by Congress as a "study river" for possible inclusion in the system while the river is in an official study status, unless the appropriate Federal agency with direct management responsibility for such river, has determined in writing that the proposed activity will not adversely affect the Wild and Scenic River designation or study status. Information on Wild and Scenic Rivers may be obtained from the appropriate Federal land management agency responsible for the designated Wild and Scenic River or study river (e.g., National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service).

17. Tribal Rights. No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights.

18. Endangered Species. (a) No activity is authorized under any NWP which is likely to directly or indirectly jeopardize the continued existence of a threatened or endangered species or

a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or which will directly or indirectly destroy or adversely modify the critical habitat of such species. No activity is authorized under any NWP which "may affect" a listed species or critical habitat, unless Section 7 consultation addressing the effects of the proposed activity has been completed.

(b) Federal agencies should follow their own procedures for complying with the requirements of the ESA. Federal permittees must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will review the documentation and determine whether it is sufficient to address ESA compliance for the NWP activity, or whether additional ESA consultation is necessary.

(c) Non-federal permittees must submit a pre-construction notification to the district engineer if any listed species or designated critical habitat might be affected or is in the vicinity of the project, or if the project is located in designated critical habitat, and shall not begin work on the activity until notified by the district engineer that the requirements of the ESA have been satisfied and that the activity is authorized. For activities that might affect Federally-listed endangered or threatened species or designated critical habitat, the pre-construction notification must include the name(s) of the endangered or threatened species that might be affected by the proposed work or that utilize the designated critical habitat that might be affected by the proposed work. The district engineer will determine whether the proposed activity "may affect" or will have "no effect" to listed species and designated critical habitat and will notify the non-Federal applicant of the Corps' determination within 45 days of receipt of a complete pre-construction notification. In cases where the non-Federal applicant has identified listed species or critical habitat that might be affected or is in the vicinity of the project, and has so notified the Corps, the applicant shall not begin work until the Corps has provided notification the proposed activities will have "no effect" on listed species or critical habitat, or until Section 7 consultation has been completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.

(d) As a result of formal or informal consultation with the FWS or NMFS the district engineer may add species-specific regional endangered species conditions to the NWPs.

(e) Authorization of an activity by a NWP does not authorize the "take" of a threatened or endangered species as defined under the ESA. In the absence of separate authorization (e.g., an ESA Section 10 Permit, a Biological Opinion with "incidental take" provisions, etc.) from the U.S. FWS or the NMFS, The Endangered Species Act prohibits any person subject to the jurisdiction of the United States to take a listed species, where "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. The word "harm" in the definition of "take" means an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering.

(f) Information on the location of threatened and endangered species and their critical habitat can be obtained directly from the offices of the U.S. FWS and NMFS or their world wide web pages at http://www.fws.gov/ or http://www.fws.gov/ipac and http://www.noaa.gov/fisheries.html respectively.

19. Migratory Birds and Bald and Golden Eagles. The permittee is responsible for obtaining any "take" permits required under the U.S. Fish and Wildlife Service's regulations

governing compliance with the Migratory Bird Treaty Act or the Bald and Golden Eagle Protection Act. The permittee should contact the appropriate local office of the U.S. Fish and Wildlife Service to determine if such "take" permits are required for a particular activity.

20. Historic Properties. (a) In cases where the district engineer determines that the activity may affect properties listed, or eligible for listing, in the National Register of Historic Places, the activity is not authorized, until the requirements of Section 106 of the National Historic Preservation Act (NHPA) have been satisfied.

(b) Federal permittees should follow their own procedures for complying with the requirements of Section 106 of the National Historic Preservation Act. Federal permittees must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will review the documentation and determine whether it is sufficient to address section 106 compliance for the NWP activity, or whether additional section 106 consultation is necessary.

(c) Non-federal permittees must submit a pre-construction notification to the district engineer if the authorized activity may have the potential to cause effects to any historic properties listed on, determined to be eligible for listing on, or potentially eligible for listing on the National Register of Historic Places, including previously unidentified properties. For such activities, the pre-construction notification must state which historic properties may be affected by the proposed work or include a vicinity map indicating the location of the historic properties or the potential for the presence of historic properties. Assistance regarding information on the location of or potential for the presence of historic resources can be sought from the State Historic Preservation Officer or Tribal Historic Preservation Officer, as appropriate, and the National Register of Historic Places (see 33 CFR 330.4(g)). When reviewing pre-construction notifications, district engineers will comply with the current procedures for addressing the requirements of Section 106 of the National Historic Preservation Act. The district engineer shall make a reasonable and good faith effort to carry out appropriate identification efforts, which may include background research, consultation, oral history interviews, sample field investigation, and field survey. Based on the information submitted and these efforts, the district engineer shall determine whether the proposed activity has the potential to cause an effect on the historic properties. Where the non-Federal applicant has identified historic properties on which the activity may have the potential to cause effects and so notified the Corps, the non-Federal applicant shall not begin the activity until notified by the district engineer either that the activity has no potential to cause effects or that consultation under Section 106 of the NHPA has been completed.

(d) The district engineer will notify the prospective permittee within 45 days of receipt of a complete pre-construction notification whether NHPA Section 106 consultation is required. Section 106 consultation is not required when the Corps determines that the activity does not have the potential to cause effects on historic properties (see 36 CFR §800.3(a)). If NHPA section 106 consultation is required and will occur, the district engineer will notify the non-Federal applicant that he or she cannot begin work until Section 106 consultation is completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.

(e) Prospective permittees should be aware that section 110k of the NHPA (16 U.S.C. 470h-2(k)) prevents the Corps from granting a permit or other assistance to an applicant who, with intent to avoid the requirements of Section 106 of the NHPA, has intentionally significantly adversely affected a historic property to which the permit would relate, or having legal power to prevent it, allowed such significant adverse effect to occur, unless the Corps, after consultation with the Advisory Council on Historic Preservation (ACHP), determines that circumstances justify granting such assistance despite the adverse effect created or permitted by the applicant. If circumstances justify granting the assistance, the Corps is required to notify the ACHP and provide documentation specifying the circumstances, the degree of damage to the integrity of any historic properties affected, and proposed mitigation. This documentation must include any views obtained from the applicant, SHPO/THPO, appropriate Indian tribes if the undertaking occurs on or affects historic properties on tribal lands or affects properties of interest to those tribes, and other parties known to have a legitimate interest in the impacts to the permitted activity on historic properties.

21. Discovery of Previously Unknown Remains and Artifacts. If you discover any previously unknown historic, cultural or archeological remains and artifacts while accomplishing the activity authorized by this permit, you must immediately notify the district engineer of what you have found, and to the maximum extent practicable, avoid construction activities that may affect the remains and artifacts until the required coordination has been completed. The district engineer will initiate the Federal, Tribal and state coordination required to determine if the items or remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

22. Designated Critical Resource Waters. Critical resource waters include, NOAA-managed marine sanctuaries and marine monuments, and National Estuarine Research Reserves. The district engineer may designate, after notice and opportunity for public comment, additional waters officially designated by a state as having particular environmental or ecological significance, such as outstanding national resource waters or state natural heritage sites. The district engineer may also designate additional critical resource waters after notice and opportunity for public comment.

(a) Discharges of dredged or fill material into waters of the United States are not authorized by NWPs 7, 12, 14, 16, 17, 21, 29, 31, 35, 39, 40, 42, 43, 44, 49, 50, 51, and 52 for any activity within, or directly affecting, critical resource waters, including wetlands adjacent to such waters.

(b) For NWPs 3, 8, 10, 13, 15, 18, 19, 22, 23, 25, 27, 28, 30, 33, 34, 36, 37, and 38, notification is required in accordance with general condition 31, for any activity proposed in the designated critical resource waters including wetlands adjacent to those waters. The district engineer may authorize activities under these NWPs only after it is determined that the impacts to the critical resource waters will be no more than minimal.

23. Mitigation. The district engineer will consider the following factors when determining appropriate and practicable mitigation necessary to ensure that adverse effects on the aquatic environment are minimal:

(a) The activity must be designed and constructed to avoid and minimize adverse effects, both temporary and permanent, to waters of the United States to the maximum extent practicable at the project site (i.e., on site).

(b) Mitigation in all its forms (avoiding, minimizing, rectifying, reducing, or compensating for resource losses) will be required to the extent necessary to ensure that the adverse effects to the aquatic environment are minimal.

(c) Compensatory mitigation at a minimum one-for-one ratio will be required for all wetland losses that exceed 1/10-acre and require pre-construction notification, unless the district engineer determines in writing that either some other form of mitigation would be more environmentally appropriate or the adverse effects of the proposed activity are minimal, and provides a project-specific waiver of this requirement. For wetland losses of 1/10-acre or less that require pre-construction notification, the district engineer may determine on a case-by-case basis that compensatory mitigation is required to ensure that the activity results in minimal adverse effects on the aquatic environment. Compensatory mitigation projects provided to offset losses of aquatic resources must comply with the applicable provisions of 33 CFR part 332.

(1) The prospective permittee is responsible for proposing an appropriate compensatory mitigation option if compensatory mitigation is necessary to ensure that the activity results in minimal adverse effects on the aquatic environment.

(2) Since the likelihood of success is greater and the impacts to potentially valuable uplands are reduced, wetland restoration should be the first compensatory mitigation option considered.

(3) If permittee-responsible mitigation is the proposed option, the prospective permittee is responsible for submitting a mitigation plan. A conceptual or detailed mitigation plan may be used by the district engineer to make the decision on the NWP verification request, but a final mitigation plan that addresses the applicable requirements of 33 CFR 332.4(c)(2) – (14) must be approved by the district engineer before the permittee begins work in waters of the United States, unless the district engineer determines that prior approval of the final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation (see 33 CFR 332.3(k)(3)).

(4) If mitigation bank or in-lieu fee program credits are the proposed option, the mitigation plan only needs to address the baseline conditions at the impact site and the number of credits to be provided.

(5) Compensatory mitigation requirements (e.g., resource type and amount to be provided as compensatory mitigation, site protection, ecological performance standards, monitoring requirements) may be addressed through conditions added to the NWP authorization, instead of components of a compensatory mitigation plan.

(d) For losses of streams or other open waters that require pre-construction notification, the district engineer may require compensatory mitigation, such as stream rehabilitation, enhancement, or preservation, to ensure that the activity results in minimal adverse effects on the aquatic environment.

(e) Compensatory mitigation will not be used to increase the acreage losses allowed by the acreage limits of the NWPs. For example, if an NWP has an acreage limit of 1/2-acre, it cannot be used to authorize any project resulting in the loss of greater than 1/2-acre of waters of the United States, even if compensatory mitigation is provided that replaces or restores some of the lost waters. However, compensatory mitigation can and should be used, as necessary, to ensure that a project already meeting the established acreage limits also satisfies the minimal impact requirement associated with the NWPs.

(f) Compensatory mitigation plans for projects in or near streams or other open waters will normally include a requirement for the restoration or establishment, maintenance, and legal protection (e.g., conservation easements) of riparian areas next to open waters. In some cases, riparian areas may be the only compensatory mitigation required. Riparian areas should consist of native species. The width of the required riparian area will address documented water quality or aquatic habitat loss concerns. Normally, the riparian area will be 25 to 50 feet wide on each side of the stream, but the district engineer may require slightly wider riparian areas to address documented water quality or habitat loss concerns. If it is not possible to establish a riparian area on both sides of a stream, or if the waterbody is a lake or coastal waters, then restoring or establishing a riparian area along a single bank or shoreline may be sufficient. Where both wetlands and open waters exist on the project site, the district engineer will determine the appropriate compensatory mitigation (e.g., riparian areas and/or wetlands compensation) based on what is best for the aquatic environment on a watershed basis. In cases where riparian areas are determined to be the most appropriate form of compensatory mitigation, the district engineer may waive or reduce the requirement to provide wetland compensatory mitigation for wetland losses.

(g) Permittees may propose the use of mitigation banks, in-lieu fee programs, or separate permittee-responsible mitigation. For activities resulting in the loss of marine or estuarine resources, permittee-responsible compensatory mitigation may be environmentally preferable if there are no mitigation banks or in-lieu fee programs in the area that have marine or estuarine credits available for sale or transfer to the permittee. For permittee-responsible mitigation, the special conditions of the NWP verification must clearly indicate the party or parties responsible for the implementation and performance of the compensatory mitigation project, and, if required, its long-term management.

(h) Where certain functions and services of waters of the United States are permanently adversely affected, such as the conversion of a forested or scrub-shrub wetland to a herbaceous wetland in a permanently maintained utility line right-of-way, mitigation may be required to reduce the adverse effects of the project to the minimal level.

24. Safety of Impoundment Structures. To ensure that all impoundment structures are safely designed, the district engineer may require non-Federal applicants to demonstrate that the structures comply with established state dam safety criteria or have been designed by qualified persons. The district engineer may also require documentation that the design has been independently reviewed by similarly qualified persons, and appropriate modifications made to ensure safety.

25. Water Quality. Where States and authorized Tribes, or EPA where applicable, have not previously certified compliance of an NWP with CWA Section 401, individual 401 Water Quality Certification must be obtained or waived (see 33 CFR 330.4(c)). The district engineer or State or Tribe may require additional water quality management measures to ensure that the authorized activity does not result in more than minimal degradation of water quality.

26. Coastal Zone Management. In coastal states where an NWP has not previously received a state coastal zone management consistency concurrence, an individual state coastal zone management consistency concurrence must be obtained, or a presumption of concurrence must occur (see 33 CFR 330.4(d)). The district engineer or a State may require additional measures to ensure that the authorized activity is consistent with state coastal zone management requirements.

27. Regional and Case-By-Case Conditions. The activity must comply with any regional conditions that may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the Corps or by the state, Indian Tribe, or U.S. EPA in its section 401 Water Quality Certification, or by the state in its Coastal Zone Management Act consistency determination.

28. Use of Multiple Nationwide Permits. The use of more than one NWP for a single and complete project is prohibited, except when the acreage loss of waters of the United States authorized by the NWPs does not exceed the acreage limit of the NWP with the highest specified acreage limit. For example, if a road crossing over tidal waters is constructed under NWP 14, with associated bank stabilization authorized by NWP 13, the maximum acreage loss of waters of the United States for the total project cannot exceed 1/3-acre.

29. Transfer of Nationwide Permit Verifications. If the permittee sells the property associated with a nationwide permit verification, the permittee may transfer the nationwide permit verification to the new owner by submitting a letter to the appropriate Corps district office to validate the transfer. A copy of the nationwide permit verification must be attached to the letter, and the letter must contain the following statement and signature:

"When the structures or work authorized by this nationwide permit are still in existence at the time the property is transferred, the terms and conditions of this nationwide permit, including any special conditions, will continue to be binding on the new owner(s) of the property. To validate the transfer of this nationwide permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below."

____

(Transferee)

____

(Date)

30. Compliance Certification. Each permittee who receives an NWP verification letter from the Corps must provide a signed certification documenting completion of the authorized activity and any required compensatory mitigation. The success of any required permittee-responsible mitigation, including the achievement of ecological performance standards, will be addressed separately by the district engineer. The Corps will provide the permittee the certification document with the NWP verification letter. The certification document will include:

(a) A statement that the authorized work was done in accordance with the NWP authorization, including any general, regional, or activity-specific conditions;

(b) A statement that the implementation of any required compensatory mitigation was completed in accordance with the permit conditions. If credits from a mitigation bank or in-lieu fee program are used to satisfy the compensatory mitigation requirements, the certification must include the documentation required by 33 CFR 332.3(l)(3) to confirm that the permittee secured the appropriate number and resource type of credits; and

(c) The signature of the permittee certifying the completion of the work and mitigation.

31. Pre-Construction Notification. (a) Timing. Where required by the terms of the NWP, the prospective permittee must notify the district engineer by submitting a pre-construction notification (PCN) as early as possible. The district engineer must determine if the PCN is complete within 30 calendar days of the date of receipt and, if the PCN is determined to be incomplete, notify the prospective permittee within that 30 day period to request the additional information necessary to make the PCN complete. The request must specify the information needed to make the PCN complete. As a general rule, district engineers will request additional information necessary to make the PCN complete only once. However, if the prospective permittee does not provide all of the requested information, then the district engineer will notify the prospective permittee that the PCN is still incomplete and the PCN review process will not commence until all of the requested information has been received by the district engineer. The prospective permittee shall not begin the activity until either:

(1) He or she is notified in writing by the district engineer that the activity may proceed under the NWP with any special conditions imposed by the district or division engineer; or

(2) 45 calendar days have passed from the district engineer's receipt of the complete PCN and the prospective permittee has not received written notice from the district or division engineer. However, if the permittee was required to notify the Corps pursuant to general condition 18 that listed species or critical habitat might be affected or in the vicinity of the project, or to notify the Corps pursuant to general condition 20 that the activity may have the potential to cause effects to historic properties, the permittee cannot begin the activity until receiving written notification from the Corps that there is "no effect" on listed species or "no potential to cause effects" on historic properties, or that any consultation required under Section 7 of the Endangered Species Act (see 33 CFR 330.4(f)) and/or Section 106 of the National Historic Preservation (see 33 CFR 330.4(g)) has been completed. Also, work cannot begin under NWPs 21, 49, or 50 until the permittee has received written approval from the Corps. If the proposed activity requires a written waiver to exceed specified limits of an NWP, the permittee may not begin the activity until the district engineer issues the waiver. If the district or division engineer notifies the permittee in writing that an individual permit is required within 45 calendar days of receipt of a complete PCN, the permittee cannot begin the activity until an individual permit has been obtained. Subsequently, the permittee's right to proceed under the NWP may be modified, suspended, or revoked only in accordance with the procedure set forth in 33 CFR 330.5(d)(2).

(b) Contents of Pre-Construction Notification: The PCN must be in writing and include the following information:

(1) Name, address and telephone numbers of the prospective permittee;

(2) Location of the proposed project;

(3) A description of the proposed project; the project's purpose; direct and indirect adverse environmental effects the project would cause, including the anticipated amount of loss of water of the United States expected to result from the NWP activity, in acres, linear feet, or other appropriate unit of measure; any other NWP(s), regional general permit(s), or individual permit(s) used or intended to be used to authorize any part of the proposed project or any related activity. The description should be sufficiently detailed to allow the district engineer to determine that the adverse effects of the project will be minimal and to determine the need for compensatory mitigation. Sketches should be provided when necessary to show that the activity

complies with the terms of the NWP. (Sketches usually clarify the project and when provided results in a quicker decision. Sketches should contain sufficient detail to provide an illustrative description of the proposed activity (e.g., a conceptual plan), but do not need to be detailed engineering plans);

(4) The PCN must include a delineation of wetlands, other special aquatic sites, and other waters, such as lakes and ponds, and perennial, intermittent, and ephemeral streams, on the project site. Wetland delineations must be prepared in accordance with the current method required by the Corps. The permittee may ask the Corps to delineate the special aquatic sites and other waters on the project site, but there may be a delay if the Corps does the delineation, especially if the project site is large or contains many waters of the United States. Furthermore, the 45 day period will not start until the delineation has been submitted to or completed by the Corps, as appropriate;

(5) If the proposed activity will result in the loss of greater than 1/10-acre of wetlands and a PCN is required, the prospective permittee must submit a statement describing how the mitigation requirement will be satisfied, or explaining why the adverse effects are minimal and why compensatory mitigation should not be required. As an alternative, the prospective permittee may submit a conceptual or detailed mitigation plan.

(6) If any listed species or designated critical habitat might be affected or is in the vicinity of the project, or if the project is located in designated critical habitat, for non-Federal applicants the PCN must include the name(s) of those endangered or threatened species that might be affected by the proposed work or utilize the designated critical habitat that may be affected by the proposed work. Federal applicants must provide documentation demonstrating compliance with the Endangered Species Act; and

(7) For an activity that may affect a historic property listed on, determined to be eligible for listing on, or potentially eligible for listing on, the National Register of Historic Places, for non-Federal applicants the PCN must state which historic property may be affected by the proposed work or include a vicinity map indicating the location of the historic property. Federal applicants must provide documentation demonstrating compliance with Section 106 of the National Historic Preservation Act.

(c) <u>Form of Pre-Construction Notification</u>: The standard individual permit application form (Form ENG 4345) may be used, but the completed application form must clearly indicate that it is a PCN and must include all of the information required in paragraphs (b)(1) through (7) of this general condition. A letter containing the required information may also be used.

(d) <u>Agency Coordination</u>: (1) The district engineer will consider any comments from Federal and state agencies concerning the proposed activity's compliance with the terms and conditions of the NWPs and the need for mitigation to reduce the project's adverse environmental effects to a minimal level.

(2) For all NWP activities that require pre-construction notification and result in the loss of greater than 1/2-acre of waters of the United States, for NWP 21, 29, 39, 40, 42, 43, 44, 50, 51, and 52 activities that require pre-construction notification and will result in the loss of greater than 300 linear feet of intermittent and ephemeral stream bed, and for all NWP 48 activities that require pre-construction notification, the district engineer will immediately provide (e.g., via e-mail, facsimile transmission, overnight mail, or other expeditious manner) a copy of the complete PCN to the appropriate Federal or state offices (U.S. FWS, state natural resource or water quality agency, EPA, State Historic Preservation Officer (SHPO) or Tribal Historic Preservation Office (THPO), and, if appropriate, the NMFS). With the exception of NWP 37,

these agencies will have 10 calendar days from the date the material is transmitted to telephone or fax the district engineer notice that they intend to provide substantive, site-specific comments. The comments must explain why the agency believes the adverse effects will be more than minimal. If so contacted by an agency, the district engineer will wait an additional 15 calendar days before making a decision on the pre-construction notification. The district engineer will fully consider agency comments received within the specified time frame concerning the proposed activity's compliance with the terms and conditions of the NWPs, including the need for mitigation to ensure the net adverse environmental effects to the aquatic environment of the proposed activity are minimal. The district engineer will provide no response to the resource agency, except as provided below. The district engineer will indicate in the administrative record associated with each pre-construction notification that the resource agencies' concerns were considered. For NWP 37, the emergency watershed protection and rehabilitation activity may proceed immediately in cases where there is an unacceptable hazard to life or a significant loss of property or economic hardship will occur. The district engineer will consider any comments received to decide whether the NWP 37 authorization should be modified, suspended, or revoked in accordance with the procedures at 33 CFR 330.5.

(3) In cases of where the prospective permittee is not a Federal agency, the district engineer will provide a response to NMFS within 30 calendar days of receipt of any Essential Fish Habitat conservation recommendations, as required by Section 305(b)(4)(B) of the Magnuson-Stevens Fishery Conservation and Management Act.

(4) Applicants are encouraged to provide the Corps with either electronic files or multiple copies of pre-construction notifications to expedite agency coordination.

D. District Engineer's Decision

1. In reviewing the PCN for the proposed activity, the district engineer will determine whether the activity authorized by the NWP will result in more than minimal individual or cumulative adverse environmental effects or may be contrary to the public interest. For a linear project, this determination will include an evaluation of the individual crossings to determine whether they individually satisfy the terms and conditions of the NWP(s), as well as the cumulative effects caused by all of the crossings authorized by NWP. If an applicant requests a waiver of the 300 linear foot limit on impacts to intermittent or ephemeral streams or of an otherwise applicable limit, as provided for in NWPs 13, 21, 29, 36, 39, 40, 42, 43, 44, 50, 51 or 52, the district engineer will only grant the waiver upon a written determination that the NWP activity will result in minimal adverse effects. When making minimal effects determinations the district engineer will consider the direct and indirect effects caused by the NWP activity. The district engineer will also consider site specific factors, such as the environmental setting in the vicinity of the NWP activity, the type of resource that will be affected by the NWP activity, the functions provided by the aquatic resources that will be affected by the NWP activity, the degree or magnitude to which the aquatic resources perform those functions, the extent that aquatic resource functions will be lost as a result of the NWP activity (e.g., partial or complete loss), the duration of the adverse effects (temporary or permanent), the importance of the aquatic resource functions to the region (e.g., watershed or ecoregion), and mitigation required by the district engineer. If an appropriate functional assessment method is available and practicable to use, that assessment method may be used by the district engineer to assist in the minimal adverse effects

determination. The district engineer may add case-specific special conditions to the NWP authorization to address site-specific environmental concerns.

2. If the proposed activity requires a PCN and will result in a loss of greater than 1/10-acre of wetlands, the prospective permittee should submit a mitigation proposal with the PCN. Applicants may also propose compensatory mitigation for projects with smaller impacts. The district engineer will consider any proposed compensatory mitigation the applicant has included in the proposal in determining whether the net adverse environmental effects to the aquatic environment of the proposed activity are minimal. The compensatory mitigation proposal may be either conceptual or detailed. If the district engineer determines that the activity complies with the terms and conditions of the NWP and that the adverse effects on the aquatic environment are minimal, after considering mitigation, the district engineer will notify the permittee and include any activity-specific conditions in the NWP verification the district engineer deems necessary. Conditions for compensatory mitigation requirements must comply with the appropriate provisions at 33 CFR 332.3(k). The district engineer must approve the final mitigation plan before the permittee commences work in waters of the United States, unless the district engineer determines that prior approval of the final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation. If the prospective permittee elects to submit a compensatory mitigation plan with the PCN, the district engineer will expeditiously review the proposed compensatory mitigation plan. The district engineer must review the proposed compensatory mitigation plan within 45 calendar days of receiving a complete PCN and determine whether the proposed mitigation would ensure no more than minimal adverse effects on the aquatic environment. If the net adverse effects of the project on the aquatic environment (after consideration of the compensatory mitigation proposal) are determined by the district engineer to be minimal, the district engineer will provide a timely written response to the applicant. The response will state that the project can proceed under the terms and conditions of the NWP, including any activity-specific conditions added to the NWP authorization by the district engineer.

3. If the district engineer determines that the adverse effects of the proposed work are more than minimal, then the district engineer will notify the applicant either: (a) That the project does not qualify for authorization under the NWP and instruct the applicant on the procedures to seek authorization under an individual permit; (b) that the project is authorized under the NWP subject to the applicant's submission of a mitigation plan that would reduce the adverse effects on the aquatic environment to the minimal level; or (c) that the project is authorized under the NWP with specific modifications or conditions. Where the district engineer determines that mitigation is required to ensure no more than minimal adverse effects occur to the aquatic environment, the activity will be authorized within the 45-day PCN period, with activity-specific conditions that state the mitigation requirements. The authorization will include the necessary conceptual or detailed mitigation or a requirement that the applicant submit a mitigation plan that would reduce the adverse effects on the aquatic environment to the minimal level. When mitigation is required, no work in waters of the United States may occur until the district engineer has approved a specific mitigation plan or has determined that prior approval of a final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation.

E. Further Information

1. District Engineers have authority to determine if an activity complies with the terms and conditions of an NWP.

2. NWPs do not obviate the need to obtain other federal, state, or local permits, approvals, or authorizations required by law.

3. NWPs do not grant any property rights or exclusive privileges.

4. NWPs do not authorize any injury to the property or rights of others.

5. NWPs do not authorize interference with any existing or proposed Federal project.

F. Definitions

Best management practices (BMPs): Policies, practices, procedures, or structures implemented to mitigate the adverse environmental effects on surface water quality resulting from development. BMPs are categorized as structural or non-structural.

Compensatory mitigation: The restoration (re-establishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved.

Currently serviceable: Useable as is or with some maintenance, but not so degraded as to essentially require reconstruction.

Direct effects: Effects that are caused by the activity and occur at the same time and place.

Discharge: The term "discharge" means any discharge of dredged or fill material.

Enhancement: The manipulation of the physical, chemical, or biological characteristics of an aquatic resource to heighten, intensify, or improve a specific aquatic resource function(s). Enhancement results in the gain of selected aquatic resource function(s), but may also lead to a decline in other aquatic resource function(s). Enhancement does not result in a gain in aquatic resource area.

Ephemeral stream: An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow.

Establishment (creation): The manipulation of the physical, chemical, or biological characteristics present to develop an aquatic resource that did not previously exist at an upland site. Establishment results in a gain in aquatic resource area.

High Tide Line: The line of intersection of the land with the water's surface at the maximum height reached by a rising tide. The high tide line may be determined, in the absence of actual data, by a line of oil or scum along shore objects, a more or less continuous deposit of fine shell or debris on the foreshore or berm, other physical markings or characteristics, vegetation lines, tidal gages, or other suitable means that delineate the general height reached by a rising tide. The line encompasses spring high tides and other high tides that occur with periodic frequency but does not include storm surges in which there is a departure from the normal or predicted reach of the tide due to the piling up of water against a coast by strong winds such as those accompanying a hurricane or other intense storm.

Historic Property: Any prehistoric or historic district, site (including archaeological site), building, structure, or other object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria (36 CFR part 60).

Independent utility: A test to determine what constitutes a single and complete non-linear project in the Corps regulatory program. A project is considered to have independent utility if it would be constructed absent the construction of other projects in the project area. Portions of a multi-phase project that depend upon other phases of the project do not have independent utility. Phases of a project that would be constructed even if the other phases were not built can be considered as separate single and complete projects with independent utility.

Indirect effects: Effects that are caused by the activity and are later in time or farther removed in distance, but are still reasonably foreseeable.

Intermittent stream: An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow.

Loss of waters of the United States: Waters of the United States that are permanently adversely affected by filling, flooding, excavation, or drainage because of the regulated activity. Permanent adverse effects include permanent discharges of dredged or fill material that change an aquatic area to dry land, increase the bottom elevation of a waterbody, or change the use of a waterbody. The acreage of loss of waters of the United States is a threshold measurement of the impact to jurisdictional waters for determining whether a project may qualify for an NWP; it is not a net threshold that is calculated after considering compensatory mitigation that may be used to offset losses of aquatic functions and services. The loss of stream bed includes the linear feet of stream bed that is filled or excavated. Waters of the United States temporarily filled, flooded, excavated, or drained, but restored to pre-construction contours and elevations after construction, are not included in the measurement of loss of waters of the United States. Impacts resulting from activities eligible for exemptions under Section 404(f) of the Clean Water Act are not considered when calculating the loss of waters of the United States.

Non-tidal wetland: A non-tidal wetland is a wetland that is not subject to the ebb and flow of tidal waters. The definition of a wetland can be found at 33 CFR 328.3(b). Non-tidal wetlands contiguous to tidal waters are located landward of the high tide line (i.e., spring high tide line).

Open water: For purposes of the NWPs, an open water is any area that in a year with normal patterns of precipitation has water flowing or standing above ground to the extent that an ordinary high water mark can be determined. Aquatic vegetation within the area of standing or flowing water is either non-emergent, sparse, or absent. Vegetated shallows are considered to be open waters. Examples of "open waters" include rivers, streams, lakes, and ponds.

Ordinary High Water Mark: An ordinary high water mark is a line on the shore established by the fluctuations of water and indicated by physical characteristics, or by other appropriate means that consider the characteristics of the surrounding areas (see 33 CFR 328.3(e)).

Perennial stream: A perennial stream has flowing water year-round during a typical year. The water table is located above the stream bed for most of the year. Groundwater is the primary source of water for stream flow. Runoff from rainfall is a supplemental source of water for stream flow.

Practicable: Available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.

Pre-construction notification: A request submitted by the project proponent to the Corps for confirmation that a particular activity is authorized by nationwide permit. The request may be a permit application, letter, or similar document that includes information about the proposed work and its anticipated environmental effects. Pre-construction notification may be required by the terms and conditions of a nationwide permit, or by regional conditions. A pre-construction notification may be voluntarily submitted in cases where pre-construction notification is not required and the project proponent wants confirmation that the activity is authorized by nationwide permit.

Preservation: The removal of a threat to, or preventing the decline of, aquatic resources by an action in or near those aquatic resources. This term includes activities commonly associated with the protection and maintenance of aquatic resources through the implementation of appropriate legal and physical mechanisms. Preservation does not result in a gain of aquatic resource area or functions.

Re-establishment: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former aquatic resource. Re-establishment results in rebuilding a former aquatic resource and results in a gain in aquatic resource area and functions.

Rehabilitation: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded aquatic resource. Rehabilitation results in a gain in aquatic resource function, but does not result in a gain in aquatic resource area.

Restoration: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource. For the purpose of tracking net gains in aquatic resource area, restoration is divided into two categories: re-establishment and rehabilitation.

Riffle and pool complex: Riffle and pool complexes are special aquatic sites under the 404(b)(1) Guidelines. Riffle and pool complexes sometimes characterize steep gradient sections of streams. Such stream sections are recognizable by their hydraulic characteristics. The rapid movement of water over a course substrate in riffles results in a rough flow, a turbulent surface, and high dissolved oxygen levels in the water. Pools are deeper areas associated with riffles. A slower stream velocity, a streaming flow, a smooth surface, and a finer substrate characterize pools.

Riparian areas: Riparian areas are lands adjacent to streams, lakes, and estuarine-marine shorelines. Riparian areas are transitional between terrestrial and aquatic ecosystems, through which surface and subsurface hydrology connects riverine, lacustrine, estuarine, and marine waters with their adjacent wetlands, non-wetland waters, or uplands. Riparian areas provide a variety of ecological functions and services and help improve or maintain local water quality. (See general condition 23.)

Shellfish seeding: The placement of shellfish seed and/or suitable substrate to increase shellfish production. Shellfish seed consists of immature individual shellfish or individual shellfish attached to shells or shell fragments (i.e., spat on shell). Suitable substrate may consist of shellfish shells, shell fragments, or other appropriate materials placed into waters for shellfish habitat.

Single and complete linear project: A linear project is a project constructed for the purpose of getting people, goods, or services from a point of origin to a terminal point, which often involves multiple crossings of one or more waterbodies at separate and distant locations. The term "single and complete project" is defined as that portion of the total linear project proposed or accomplished by one owner/developer or partnership or other association of owners/developers that includes all crossings of a single water of the United States (i.e., a single waterbody) at a specific location. For linear projects crossing a single or multiple waterbodies several times at separate and distant locations, each crossing is considered a single and complete project for purposes of NWP authorization. However, individual channels in a braided stream or river, or individual arms of a large, irregularly shaped wetland or lake, etc., are not separate waterbodies, and crossings of such features cannot be considered separately.

Single and complete non-linear project: For non-linear projects, the term "single and complete project" is defined at 33 CFR 330.2(i) as the total project proposed or accomplished by one owner/developer or partnership or other association of owners/developers. A single and complete non-linear project must have independent utility (see definition of "independent utility"). Single and complete non-linear projects may not be "piecemealed" to avoid the limits in an NWP authorization.

Stormwater management: Stormwater management is the mechanism for controlling stormwater runoff for the purposes of reducing downstream erosion, water quality degradation, and flooding and mitigating the adverse effects of changes in land use on the aquatic environment.

Stormwater management facilities: Stormwater management facilities are those facilities, including but not limited to, stormwater retention and detention ponds and best management practices, which retain water for a period of time to control runoff and/or improve the quality (i.e., by reducing the concentration of nutrients, sediments, hazardous substances and other pollutants) of stormwater runoff.

Stream bed: The substrate of the stream channel between the ordinary high water marks. The substrate may be bedrock or inorganic particles that range in size from clay to boulders. Wetlands contiguous to the stream bed, but outside of the ordinary high water marks, are not considered part of the stream bed.

Stream channelization: The manipulation of a stream's course, condition, capacity, or location that causes more than minimal interruption of normal stream processes. A channelized stream remains a water of the United States.

Structure: An object that is arranged in a definite pattern of organization. Examples of structures include, without limitation, any pier, boat dock, boat ramp, wharf, dolphin, weir, boom, breakwater, bulkhead, revetment, riprap, jetty, artificial island, artificial reef, permanent mooring structure, power transmission line, permanently moored floating vessel, piling, aid to navigation, or any other manmade obstacle or obstruction.

Tidal wetland: A tidal wetland is a wetland (i.e., water of the United States) that is inundated by tidal waters. The definitions of a wetland and tidal waters can be found at 33 CFR 328.3(b) and 33 CFR 328.3(f), respectively. Tidal waters rise and fall in a predictable and measurable rhythm or cycle due to the gravitational pulls of the moon and sun. Tidal waters end where the rise and fall of the water surface can no longer be practically measured in a predictable rhythm due to masking by other waters, wind, or other effects. Tidal wetlands are located channelward of the high tide line, which is defined at 33 CFR 328.3(d).

Vegetated shallows: Vegetated shallows are special aquatic sites under the 404(b)(1) Guidelines. They are areas that are permanently inundated and under normal circumstances have rooted aquatic vegetation, such as seagrasses in marine and estuarine systems and a variety of vascular rooted plants in freshwater systems.

Waterbody: For purposes of the NWPs, a waterbody is a jurisdictional water of the United States. If a jurisdictional wetland is adjacent – meaning bordering, contiguous, or neighboring – to a waterbody determined to be a water of the United States under 33 CFR 328.3(a)(1)-(6), that waterbody and its adjacent wetlands are considered together as a single aquatic unit (see 33 CFR 328.4(c)(2)). Examples of "waterbodies" include streams, rivers, lakes, ponds, and wetlands.

ADDITIONAL INFORMATION

This nationwide permit is effective March 19, 2012, and expires on March 18, 2017.

Information about the U.S. Army Corps of Engineers regulatory program, including nationwide permits, may also be accessed at http://www.swf.usace.army.mil/regulatory or
http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits.aspx

NATIONWIDE PERMIT (NWP) REGIONAL CONDITIONS FOR THE STATE OF TEXAS

The following regional conditions apply within the entire State of Texas:

1. Compensatory mitigation is required at a minimum one-for-one ratio for all special aquatic site losses that exceed 1/10 acre and require pre-construction notification (PCN), and for all losses to streams that exceed 300 linear feet and require PCN, unless the appropriate District Engineer determines in writing that some other form of mitigation would be more environmentally appropriate and provides a project-specific waiver of this requirement.

2. For all discharges proposed for authorization under nationwide permits (NWP) 3, 6, 7, 12, 14, 18, 19, 25, 27, 29, 39, 40, 41, 42, 43, 44, 51, and 52, into the following habitat types or specific areas, the applicant shall notify the appropriate District Engineer in accordance with the NWP General Condition 31, Pre-Construction Notification (PCN). The Corps of Engineers (Corps), except for the Tulsa District, will coordinate with the resource agencies as specified in NWP General Condition 31(d) (PCN). The habitat types or areas are:

a. Pitcher Plant Bogs: Wetlands typically characterized by an organic surface soil layer and include vegetation such as pitcher plants (Sarracenia sp.), sundews (Drosera sp.), and sphagnum moss (Sphagnum sp.).

b. Bald Cypress-Tupelo Swamps: Wetlands comprised predominantly of bald cypress trees (Taxodium distichum), and water tupelo trees (Nyssa aquatica), that are occasionally or regularly flooded by fresh water. Common associates include red maple (Acer rubrum), swamp privet (Forestiera acuminata), green ash (Fraxinus pennsylvanica) and water elm (Planera aquatica). Associated herbaceous species include lizard's tail (Saururus cernuus), water mermaid weed (Proserpinaca spp.), buttonbush (Cephalanthus occidentalis) and smartweed (Polygonum spp.). (Eyre, F. H. Forest Cover Types of the United States and Canada. 1980. Society of American Foresters, 5400 Grosvenor Lane, Bethesda, Maryland 20814-2198. Library of Congress Catalog Card No. 80-54185)

3. For all activities proposed for authorization under NWP 12 that involve a discharge of fill material associated with mechanized land clearing in a forested wetland, the applicant shall notify the appropriate District Engineer in accordance with the NWP General Condition 31 (Pre-Construction Notification) prior to commencing the activity.

4. For all activities proposed for authorization under NWP 16, the applicant shall notify the appropriate District Engineer in accordance with the NWP General Condition 31 (Pre-Construction Notification), and work cannot begin under NWP 16 until the applicant has received written approval from the Corps.

The following regional conditions apply only within the Fort Worth District in the State of Texas:

5. For all discharges proposed for authorization under all NWPs, into the area of Caddo Lake within Texas that is designated as a "Wetland of International Importance" under the Ramsar Convention, the applicant shall notify the Fort Worth District Engineer in accordance with the NWP General Condition 31. The Corps will coordinate with the resource agencies as specified in NWP General Condition 31(d) (Pre-Construction Notification).

6. For all discharges proposed for authorization under NWP 43 that occur in forested wetlands, the applicant shall notify the Fort Worth District Engineer in accordance with the General Condition 31 (Pre-Construction Notification).

7. For all discharges proposed for authorization under any nationwide permit in Dallas, Denton, and Tarrant Counties that are within the study area of the "Final Regional Environmental Impact Statement (EIS), Trinity River and Tributaries" (May 1986), the applicant shall meet the criteria and follow the guidelines specified in Section III of the Record of Decision for the Regional EIS, including the hydraulic impact requirements. A copy of these guidelines is available upon request from the Fort Worth District and at the District website www.swf.usace.army.mil (select "Permits").

8. Federal Projects. The applicant shall notify the Forth Worth District Engineer in accordance with the NWP General Condition 31, Pre-Construction Notification (PCN) for any regulated activity where the applicant is proposing work that would result in the modification or alteration of any completed Corps of Engineer projects that are either locally or federally maintained and for work that would occur within the conservation pool or flowage easement of any Corps of Engineers lake project. PCN's cannot be deemed complete until such time as the Corps has made

a determination relative to 33 USC Section 408, 33 CFR Part 208, Section 208.10, 33 CFR Part 320, Section 320.4.

9. Invasive and Exotic Species. Best management practices are required where practicable to reduce the risk of transferring invasive plant and animal species to or from project sites. Information concerning state specific lists and threats can be found at: http://www.invasivespeciesinfo.gov/unitedstates/tx.shtml. Best management practices can be found at: http://www.invasivespeciesinfo.gov/toolkit/prevention.shtml. Known zebra mussel waters within can be found at: http://nas.er.usgs.gov/queries/zmbyst.asp.

10. For all discharges proposed for authorization under NWPs 51 and 52, the Corps will provide the PCN to the US Fish and Wildlife Service as specified in NWP General Condition 31(d)(2) for its review and comments.

Bryan W. Shaw, Ph.D., *Chairman*
Buddy Garcia, *Commissioner*
Carlos Rubinstein, *Commissioner*
Mark R. Vickery, P.G., *Executive Director*

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

April 5, 2012

Ms. Kristi N. McMillan
Galveston District CESWG-PE-RE
U.S. Army Corps of Engineers
P.O. Box 1229
Galveston, Texas 77553-1229

Re: USACE Nationwide Permits

Dear Ms. McMillan:

This letter is in response to your January 23, 2012, letter requesting Clean Water Act Section 401 certification of the United States Army Corps of Engineers (Corps) Nationwide Permits (NWPs). The Final Notice of Reissuance of Nationwide Permits was published in the Federal Register (Vol. 77, No. 34, pages 10184-10290) on February 21, 2012. Proposed regional conditions for NWPs in Texas were proposed in public notices on February 24, 2011 and November 14, 2011.

The Texas Commission on Environmental Quality (TCEQ) has reviewed the Final Notice of Reissuance of Nationwide Permits and the proposed regional conditions. On behalf of the Executive Director and based on our evaluation of the information contained in these documents, the TCEQ certifies that the activities authorized by NWPs 1, 2, 4, 5, 8, 9, 10, 11, 20, 23, 24, 28, 34, 35, and 48 should not result in a violation of established Texas Surface Water Quality Standards as required by Section 401 of the Federal Clean Water Act and pursuant to Title 30, Texas Administrative Code, Chapter 279.

The TCEQ conditionally certifies that the activities authorized by NWPs 3, 6, 7, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 29, 30, 31, 32, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 49, 50, 51 and 52 should not result in a violation of established Texas Surface Water Quality Standards as required by Section 401 of the Federal Clean Water Act and pursuant to Title 30, Texas Administrative Code, Chapter 279. Conditions for each NWP are defined in Enclosure 1 and more detail on specific conditions are discussed below.

The TCEQ understands that a prohibition against the use of NWPs in coastal dune swales will be included in the 2012 Texas Regional Conditions (Regional Conditions) for all NWPs, except for NWP 3. Inclusion of a prohibition of using NWPs in coastal dune swales, except for NWP 3, is a condition of this 401 TCEQ certification.

The TCEQ wants to clarify the application of NWP 16 in Texas. NWP 16 should be limited to the return water from upland contained dredged material disposal areas. It is important to emphasize the intent for dredged material disposal. The TCEQ understands dredged material to be associated with navigational dredging activities, not commercial mining activities. To avoid confusion the TCEQ requests that a regional condition be added that prohibits the use of NWP 16 for activities that would be regulated under Standard Industrial Classification (SIC) codes 1442 and 1446 (industrial and construction sand and gravel mining). This condition is also included as part of the 401 certification of NWP 16.

The final NWP 16 states that the quality of the return water is controlled by the state through the 401 certification procedures. Consistent with previous NWPs certification decisions the TCEQ is conditionally certifying NWP 16 for the return water from confined upland disposal not to exceed a 300 mg/L Total Suspended Solids (TSS) concentration and request the Corps to include this condition in the Regional Conditions. The TCEQ recognizes the usefulness of having an instantaneous method to determine compliance with the 300 mg/L TSS limit. However, existing literature and analysis of paired samples of turbidity and TSS from the Texas Surface Water Quality Data indicate this relationship must be a site specific characterization of the actual sediments to be dredged. To address this approach we have continued language in the NWP 16 conditional certification that allows flexibility to use an instantaneous method in implementing the TSS limit when a site specific correlation curve for turbidity (nephelometric turbidity units (NTU)) versus TSS has been approved by TCEQ. The TCEQ remains interested in working with the Corps in the development of these curves. We encourage the Corps to accept the conditional certification of NWP 16 as a Regional Condition and that we work together to find the best methods to implement this limit.

In evaluating this condition for the Regional Conditions for NWPs, the TCEQ encourages the Corps to consider that TSS limits are promulgated as effluent limits under Title 40 of the Code of Federal Regulations. The TCEQ requirement to control return water from confined upland disposal not to exceed a 300 mg/L TSS has also been included in individual 404 permits. It is also important to note that the TCEQ effectively imposes TSS effluent limits in thousands of wastewater discharge permits issued in Texas under Section 402 of the federal Clean Water Act.

The TCEQ is conditionally certifying NWP General Condition #12 *Soil Erosion and Sediment Controls*, and General Condition #25 *Water Quality*. The conditions address three broad categories of water quality management with specific recommendations for Best Management Practices (BMPs) for each category. These BMPs are intended to enhance the water quality protection of these General Conditions. A list of TCEQ-recommended BMPs is included as Enclosure 2.

Enclosure 3 is provided as a quick reference table for all NWPs. A detailed description of the BMPs is provided in Enclosure 4. Runoff from bridge decks has been exempted from the requirement for post-construction total suspended solids (TSS) controls under General Condition 25. As stated in our April 11, 2011 and November 30, 2011 letters to the Corps, the TCEQ would like to include these BMPs for the protection of waters in the state specific to each NWP as part of the regional conditions for Texas.

The TCEQ is conditionally certifying NWPs 13, 29, 39, 40, 41, 42, 43, 44, 50, 51, and 52 to require the Corps to copy TCEQ on all written approvals of waivers for impacts to ephemeral, intermittent or perennial streams. The TCEQ is conditionally certifying NWP 36 to require the Corps to copy TCEQ on all written waivers for discharges greater than the 50 cubic yard limit or boat ramps greater than 20 feet in width. The TCEQ is also conditionally certifying General Condition 23 *Mitigation* to require the Corps to copy TCEQ on any written notification of a mitigation waiver. The TCEQ is requesting this information to fulfill its responsibility to ensure water of the state is appropriately protected by understanding the impact of waivers being granted in Texas.

This certification decision is limited to those activities under the jurisdiction of the TCEQ. For activities related to the production and exploration of oil and gas, a Texas Railroad Commission certification is required as provided in the Texas Water Code §26.131.

The TCEQ has reviewed the Notice of Reissuance of Nationwide Permits for consistency with the Texas Coastal Management Program (CMP) goals and policies in accordance with the CMP regulations {Title 31, Texas Administrative Code (TAC), Chapter (§)505.30} and has determined that the action is consistent with the applicable CMP goals and policies.

This certification was reviewed for consistency with the CMP's development in critical areas policy {31 TAC §501.23} and dredging and dredged material disposal and placement policy {31 TAC §501.25}. This certification complies with the CMP goals {31 TAC §501.12(1, 2, 3, 5)} applicable to these policies.

The TCEQ reserves the right to modify this certification if additional information identifies specific areas where significant impacts, including cumulative or secondary impacts, are occurring, and the use of these NWPs would be inappropriate.

No review of property rights, location of property lines, nor the distinction between public and private ownership has been made, and this certification may not be used in any way with regard to questions of ownership.

Ms. Kristi N. McMillan
U.S. Army Corps of Engineers
USACE Nationwide Permits
Page 4
April 5, 2012

If you require further assistance, please contact Mr. John Trevino, Water Quality Assessment Section, Water Quality Division (MC-150), at (512) 239-4600.

Sincerely,

Charles W. Maguire
Water Quality Division Director
Texas Commission on Environmental Quality

CWM/JT/gg

Attachments

ccs: Mr. Stephen Brooks, Branch Chief, U.S. Army Corp of Engineers, Regulatory Branch, CESWF-PER-R, P.O. Box 17300, Fort Worth, Texas 76102-0300
Ms. Kate Zultner, Secretary, Coastal Coordination Council, P.O. Box 12873, Austin, Texas 78711-2873
Mr. Allan E. Steinle, Branch Chief, U.S. Army Corps of Engineers, Albuquerque District, 4101 Jefferson Plaza NE, Room 313, Albuquerque, New Mexico 87109-3435
Regulatory Branch Chief, U.S. Army Corps of Engineers, Regulatory Branch CESWT-PE-R, 1645 South 101st East Avenue, Tulsa, Oklahoma, 74128
Regulatory Branch Chief, U.S. Army Corps of Engineers, El Paso Regulatory Office, CESPA-OD-R-EP, P.O. Box 6096, Fort Bliss, Texas 79906-6096

Attachment 1

Attachment 1
Conditions of Section 401 Certification for Nationwide Permits and General Conditions

General Condition 12 (Soil Erosion and Sediment Controls)

Erosion control and sediment control BMPs described in Attachment 2 are required with the use of this general condition. If the applicant does not choose one of the BMPs listed in Attachment 2, an individual 401 certification is required.

General Condition 25 (Water Quality)

Post-construction total suspended solids (TSS) BMPs described in Attachment 2 are required with the use of this general condition. If the applicant does not choose one of the BMP's listed in Attachment 2, an individual 401 certification is required. Bridge deck runoff is exempt from this requirement.

General Condition 23 (Mitigation)

The U.S. Army Corps of Engineers will copy the TCEQ on all mitigation waivers sent to applicants.

NWPs 13, 29, 39, 40, 41, 42, 43, 44, 50, 51, 52

The U.S. Army Corps of Engineers will copy the TCEQ on all written approvals of waivers for impacts to ephemeral, intermittent or perennial streams.

All NWPs except for NWP 3

These NWPs are not authorized for use in coastal dune swales in Texas.

NWP 3 (Maintenance)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 6 (Survey Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 7 (Outfall Structures and Associated Intake Structures)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 12 (Utility Line Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 13 (Bank Stabilization)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 14 (Linear Transportation Projects)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 15 (U.S. Coast Guard Approved Bridges)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 16 (Return Water From Upland Contained Disposal Areas)

Activities that would be regulated under Standard Industrial Classification (SIC) codes 1442 and 1446 (industrial and construction sand and gravel mining) are not eligible for this NWP. Effluent from an upland contained disposal area shall not exceed a TSS concentration of 300 mg/L unless a site-specific TSS limit, or a site specific correlation curve for turbidity (nephelometric turbidity units (NTU)) versus (TSS) has been approved by TCEQ.

NWP 17 (Hydropower Projects)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 18 (Minor Discharges)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 19 (Minor Dredging)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 21 (Surface Coal Mining Operations)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 22 (Removal of Vessels)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 25 (Structural Discharges)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 27 (Aquatic Habitat Restoration, Establishment, and Enhancement Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 29 (Residential Developments)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 30 (Moist Soil Management for Wildlife)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 31 (Maintenance of Existing Flood Control Facilities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 32 (Completed Enforcement Actions)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 33 (Temporary Construction, Access and Dewatering)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 36 (Boat Ramps)

The U.S. Army Corps of Engineers will copy the TCEQ on all written waivers for discharges greater than the 50 cubic yard limit or boat ramps greater than 20 feet in width. Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 37 (Emergency Watershed Protection and Rehabilitation)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 38 (Cleanup of Hazardous and Toxic Waste)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 39 (Commercial and Institutional Developments)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 40 (Agricultural Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 41 (Reshaping Existing Drainage Ditches)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

Attachment 1
Conditions of Section 401 Certification for Nationwide Permits and General Conditions

NWP 42 (Recreational Facilities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 43 (Stormwater Management Facilities)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 44 (Mining Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 45 (Repair of Uplands Damaged by Discrete Events)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 46 (Discharges in Ditches)

Soil Erosion and Sediment Controls under General Condition 12 are required.

NWP 49 (Coal Remining Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 50 (Underground Coal Mining Activities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 51 (Land-Based Renewal Energy Generation Facilities)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

NWP 52 (Water-Based Renewal Energy Generation Pilot Projects)

Soil Erosion and Sediment Controls under General Condition 12 are required. Post-construction TSS controls under General Condition 25 are required.

Attachment 2

Attachment 2
401 Water Quality Certification Best Management Practices (BMPs) for Nationwide Permits

Below are the 401 water quality certification conditions the Texas Commission on Environmental Quality (TCEQ) added to the February 21, 2012 issuance of Nationwide Permits (NWP), as described in the Federal Register (Vol. 77, No. 34, pages 10184-10290).

Additional information regarding these conditions, including descriptions of the best management practices (BMPs), can be obtained from the TCEQ by contacting the 401 Coordinator, MC-150, P.O. Box 13087, Austin, Texas 78711-3087 or from the appropriate U.S. Army Corps of Engineers district office.

I. Erosion Control

Disturbed areas must be stabilized to prevent the introduction of sediment to adjacent wetlands or water bodies during wet weather conditions (erosion). *At least one* of the following BMPs must be maintained and remain in place until the area has been stabilized for NWPs 3, 6, 7, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 29, 30, 31, 32, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 49, 50, 51, and 52. If the applicant does not choose one of the BMPs listed, an individual 401 certification is required. BMPs for NWP 52 apply only to land-based impacts from attendant features.

o Temporary Vegetation

o Blankets/Matting

o Mulch

o Sod

o Interceptor Swale

o Diversion Dike

o Erosion Control Compost

o Mulch Filter Socks

o Compost Filter Socks

II. Sedimentation Control

Prior to project initiation, the project area must be isolated from adjacent wetlands and water bodies by the use of BMPs to confine sediment. Dredged material shall be placed in such a manner that prevents sediment runoff into water in the state, including wetlands. Water bodies can be isolated by the use of one or more of the required BMPs identified for sedimentation control. These BMP's must be maintained and remain in place until the dredged material is stabilized. *At least one* of the following BMPs must be maintained and remain in place until the area has been stabilized for NWPs 3, 6, 7, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 29, 30, 31, 32, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 49, 50, 51, and 52. If the applicant does not choose one of the BMPs listed, an individual 401 certification is required. BMPs for NWP 52 apply only to land-based impacts from attendant features.

o Sand Bag Berm

o Rock Berm

o Silt Fence

o Hay Bale Dike

o Triangular Filter Dike

o Brush Berms

- o Stone Outlet Sediment Traps
- o Sediment Basins
- o Erosion Control Compost
- o Mulch Filter Socks
- o Compost Filter Socks

III. Post-Construction TSS Control

After construction has been completed and the site is stabilized, total suspended solids (TSS) loadings shall be controlled by *at least one* of the following BMPs for NWPs 12, 14, 17, 18, 21, 29, 31, 36, 39, 40, 41, 42, 44, 45, 49, 50, 51, and 52. If the applicant does not choose one of the BMPs listed, an individual 401 certification is required. BMPs for NWP 52 apply only to land-based impacts from attendant features. Runoff from bridge decks has been exempted from the requirement for post construction TSS controls.

- o Retention/Irrigation Systems
- o Constructed Wetlands
- o Extended Detention Basin
- o Wet Basins
- o Vegetative Filter Strips
- o Vegetation lined drainage ditches
- o Grassy Swales
- o Sand Filter Systems
- o Erosion Control Compost
- o Mulch Filter Socks
- o Compost Filter Socks
- o Sedimentation Chambers*

* Only to be used when there is no space available for other approved BMPs.

IV. NWP 16: Return Water from Upland Contained Disposal Areas

Effluent from an upland contained disposal area shall not exceed a TSS concentration of 300 mg/L unless a site-specific TSS limit, or a site specific correlation curve for turbidity (nephelometric turbidity units (NTU)) versus (TSS) has been approved by TCEQ.

V. NWP 29, 39, 40, 42, 43, 44, 50, 51, and 52

The Corps will copy the TCEQ on all authorizations for impacts of greater than 300 linear feet of intermittent and ephemeral streams.

Attachment 2
401 Water Quality Certification Best Management Practices (BMPs) for Nationwide Permits

VI. NWP 13 and 41

The Corps will copy the TCEQ on all authorizations for impacts greater than 500 linear feet in length of ephemeral, intermittent, perennial streams or drainage ditches.

VII. NWP 36

The Corps will copy the TCEQ on all authorizations for discharges greater than the 50 cubic yard limit or boat ramps greater than 20 feet in width.

VIII. All NWPs except NWP 3

These NWPs are not authorized for use in coastal dune swales in Texas.

Attachment 3

Attachment 3
Reference to Nationwide Permits Best Management Practices Requirements

NWP	Permit Description	Erosion Control	Sediment Control	Post Construction TSS
1	Aid to Navigation			
2	Structures in Artificial Canals			
3	Maintenance	X	X	
4	Fish and Wildlife Harvesting, Enhancement and Attraction Devices and Activities			
5	Scientific Measurement Devices			
6	Survey Activities *Trenching	X	X	
7	Outfall Structures and Associated Intake Structures	X	X	
8	Oil and Gas Structures on the Outer Continental Shelf			
9	Structures in Fleeting and Anchorage Areas			
10	Mooring Buoys			
11	Temporary Recreational Structures			
12	Utility Line Activities	X	X	X
13	Bank Stabilization	X	X	
14	Linear Transportation Projects	X	X	X
15	U.S. Coast Guard Approved Bridges	X	X	
16	Return Water From Upland Contained Disposal Areas			
17	Hydropower Projects	X	X	X
18	Minor Discharges	X	X	X
19	Minor Dredging	X	X	
20	Response Operations for Oil and Hazardous Substances			
21	Surface Coal Mining Operations	X	X	X
22	Removal of Vessels	X	X	
23	Approved Categorical Exclusions			

<u>Attachment 3</u>
Reference to Nationwide Permits Best Management Practices Requirements

NWP	Permit Description	Erosion Control	Sediment Control	Post Construction TSS
24	Indian Tribe or State Administered Section 404 Programs			
25	Structural Discharges	X	X	
26	[Reserved]			
27	Aquatic Habitat Restoration, Establishment, and Enhancement Activities	X	X	
28	Modifications of Existing Marinas			
29	Residential Developments	X	X	X
30	Moist Soil Management for Wildlife	X	X	
31	Maintenance of Existing Flood Control Facilities	X	X	X
32	Completed Enforcement Actions	X	X	
33	Temporary Construction, Access and Dewatering	X	X	
34	Cranberry Production Activities			
35	Maintenance Dredging of Existing Basins			
36	Boat Ramps	X	X	X
37	Emergency Watershed Protection and Rehabilitation	X	X	
38	Cleanup of Hazardous and Toxic Waste	X	X	
39	Commercial and Institutional Developments	X	X	X
40	Agricultural Activities	X	X	X
41	Reshaping Existing Drainage Ditches	X	X	X
42	Recreational Facilities	X	X	X
43	Stormwater Management Facilities	X	X	
44	Mining Activities	X	X	X
45.	Repair of Uplands Damaged by Discrete Events	X	X	X
46.	Discharges in Ditches	X	X	

Attachment 3
Reference to Nationwide Permits Best Management Practices Requirements

NWP	Permit Description	Erosion Control	Sediment Control	Post Construction TSS
47.	[Reserved]			
48.	Existing Commercial Shellfish Aquaculture Activities			
49.	Coal Remining Activities	X	X	X
50.	Underground Coal Mining Activities	X	X	X
51.	Land-Based Renewable Energy Generation Facilities	X	X	X
52.	Water-Based Renewable Energy Generation Pilot Projects	X	X	X

Attachment 4

Attachment 4
Description of BMPs

EROSION CONTROL BMPs

Temporary Vegetation

Description: Vegetation can be used as a temporary or permanent stabilization technique for areas disturbed by construction. Vegetation effectively reduces erosion in swales, stockpiles, berms, mild to medium slopes, and along roadways. Other techniques such as matting, mulches, and grading may be required to assist in the establishment of vegetation.

Materials:

- The type of temporary vegetation used on a site is a function of the season and the availability of water for irrigation.
- Temporary vegetation should be selected appropriately for the area.
- County agricultural extension agents are a good source for suggestions for temporary vegetation.
- All seed should be high quality, U.S. Dept. of Agriculture certified seed.

Installation:

- Grading must be completed prior to seeding.
- Slopes should be minimized.
- Erosion control structures should be installed.
- Seedbeds should be well pulverized, loose, and uniform.
- Fertilizers should be applied at appropriate rates.
- Seeding rates should be applied as recommended by the county agricultural extension agent.
- The seed should be applied uniformly.
- Steep slopes should be covered with appropriate soil stabilization matting.

Blankets and Matting

Description: Blankets and matting material can be used as an aid to control erosion on critical sites during the establishment period of protective vegetation. The most common uses are in channels, interceptor swales, diversion dikes, short, steep slopes, and on tidal or stream banks.
Materials:

New types of blankets and matting materials are continuously being developed. The Texas

Department of Transportation (TxDOT) has defined the critical performance factors for these types of products and has established minimum performance standards which must be met for any product seeking to be approved for use within any of TxDOT's construction or maintenance activities. The products that have been approved by TxDOT are also appropriate for general construction site stabilization. TxDOT maintains a web site at http://www.txdot.gov/business/doing_business/product_evaluation/erosion_control.htm which is updated as new products are evaluated.

Installation:

- Install in accordance with the manufacturer's recommendations.
- Proper anchoring of the material.
- Prepare a friable seed bed relatively free from clods and rocks and any foreign material.
- Fertilize and seed in accordance with seeding or other type of planting plan.
- Erosion stops should extend beyond the channel liner to full design cross-section of the channel.
- A uniform trench perpendicular to line of flow may be dug with a spade or a mechanical trencher.
- Erosion stops should be deep enough to penetrate solid material or below level of ruling in sandy soils.
- Erosion stop mats should be wide enough to allow turnover at bottom of trench for stapling, while maintaining the top edge flush with channel surface.

Mulch

Description: Mulching is the process of applying a material to the exposed soil surface to protect it from erosive forces and to conserve soil moisture until plants can become established. When seeding critical sites, sites with adverse soil conditions or seeding on other than optimum seeding dates, mulch material should be applied immediately after seeding. Seeding during optimum seeding dates and with favorable soils and site conditions will not need to be mulched.

Materials:

- Mulch may be small grain straw which should be applied uniformly.
- On slopes 15 percent or greater, a binding chemical must be applied to the surface.
- Wood-fiber or paper-fiber mulch may be applied by hydroseeding.
- Mulch nettings may be used.

- Wood chips may be used where appropriate.

Installation:

Mulch anchoring should be accomplished immediately after mulch placement. This may be done by one of the following methods: peg and twine, mulch netting, mulch anchoring tool, or liquid mulch binders.

Sod

Description: Sod is appropriate for disturbed areas which require immediate vegetative covers, or where sodding is preferred to other means of grass establishment. Locations particularly suited to stabilization with sod are waterways carrying intermittent flow, areas around drop inlets or in grassed swales, and residential or commercial lawns where quick use or aesthetics are factors. Sod is composed of living plants and those plants must receive adequate care in order to provide vegetative stabilization on a disturbed area.

Materials:

- Sod should be machine cut at a uniform soil thickness.
- Pieces of sod should be cut to the supplier's standard width and length.
- Torn or uneven pads are not acceptable.
- Sections of sod should be strong enough to support their own weight and retain their size and shape when suspended from a firm grasp.
- Sod should be harvested, delivered, and installed within a period of 36 hours.

Installation:

- Areas to be sodded should be brought to final grade.
- The surface should be cleared of all trash and debris.
- Fertilize according to soil tests.
- Fertilizer should be worked into the soil.
- Sod should not be cut or laid in excessively wet or dry weather.
- Sod should not be laid on soil surfaces that are frozen.
- During periods of high temperature, the soil should be lightly irrigated.

- The first row of sod should be laid in a straight line with subsequent rows placed parallel to and butting tightly against each other.
- Lateral joints should be staggered to promote more uniform growth and strength.
- Wherever erosion may be a problem, sod should be laid with staggered joints and secured.
- Sod should be installed with the length perpendicular to the slope (on the contour).
- Sod should be rolled or tamped.
- Sod should be irrigated to a sufficient depth.
- Watering should be performed as often as necessary to maintain soil moisture.
- The first mowing should not be attempted until the sod is firmly rooted.
- Not more than one third of the grass leaf should be removed at any one cutting.

Interceptor Swale

Interceptor swales are used to shorten the length of exposed slope by intercepting runoff, prevent off-site runoff from entering the disturbed area, and prevent sediment-laden runoff from leaving a disturbed site. They may have a v-shape or be trapezoidal with a flat bottom and side slopes of 3:1 or flatter. The outflow from a swale should be directed to a stabilized outlet or sediment trapping device. The swales should remain in place until the disturbed area is permanently stabilized.

Materials:

- Stabilization should consist of a layer of crushed stone three inches thick, riprap or high velocity erosion control mats.
- Stone stabilization should be used when grades exceed 2% or velocities exceed 6 feet per second.
- Stabilization should extend across the bottom of the swale and up both sides of the channel to a minimum height of three inches above the design water surface elevation based on a 2-year, 24-hour storm.

Installation:

- An interceptor swale should be installed across exposed slopes during construction and should intercept no more than 5 acres of runoff.
- All earth removed and not needed in construction should be disposed of in an approved spoils site so that it will not interfere with the functioning of the swale or contribute to siltation in other areas of the site.

Attachment 4
Description of BMPs

- All trees, brush, stumps, obstructions and other material should be removed and disposed of so as not to interfere with the proper functioning of the swale.

- Swales should have a maximum depth of 1.5 feet with side slopes of 3:1 or flatter. Swales should have positive drainage for the entire length to an outlet.

- When the slope exceeds 2 percent, or velocities exceed 6 feet per second (regardless of slope), stabilization is required. Stabilization should be crushed stone placed in a layer of at least 3 inches thick or may be high velocity erosion control matting. Check dams are also recommended to reduce velocities in the swales possibly reducing the amount of stabilization necessary.

- Minimum compaction for the swale should be 90% standard proctor density.

Diversion Dikes

A temporary diversion dike is a barrier created by the placement of an earthen embankment to reroute the flow of runoff to an erosion control device or away from an open, easily erodible area. A diversion dike intercepts runoff from small upland areas and diverts it away from exposed slopes to a stabilized outlet, such as a rock berm, sandbag berm, or stone outlet structure. These controls can be used on the perimeter of the site to prevent runoff from entering the construction area. Dikes are generally used for the duration of construction to intercept and reroute runoff from disturbed areas to prevent excessive erosion until permanent drainage features are installed and/or slopes are stabilized.

Materials:

- Stone stabilization (required for velocities in excess of 6 fps) should consist of riprap placed in a layer at least 3 inches thick and should extend a minimum height of 3 inches above the design water surface up the existing slope and the upstream face of the dike.

- Geotextile fabric should be a non-woven polypropylene fabric designed specifically for use as a soil filtration media with an approximate weight of 6 oz./yd^2, a Mullen burst rating of 140 psi, and having an equivalent opening size (EOS) greater than a #50 sieve.

Installation:

- Diversion dikes should be installed prior to and maintained for the duration of construction and should intercept no more than 10 acres of runoff.

- Dikes should have a minimum top width of 2 feet and a minimum height of compacted fill of 18 inches measured form the top of the existing ground at the upslope toe to top of the dike and have side slopes of 3:1 or flatter.

- The soil for the dike should be placed in lifts of 8 inches or less and be compacted to 95 % standard proctor density.

- The channel, which is formed by the dike, must have positive drainage for its entire length to an outlet.

- When the slope exceeds 2 percent, or velocities exceed 6 feet per second (regardless of slope), stabilization is required. In situations where velocities do not exceed 6 feet per second, vegetation may be used to control erosion.

Erosion Control Compost

Description: Erosion control compost (ECC) can be used as an aid to control erosion on critical sites during the establishment period of protective vegetation. The most common uses are on steep slopes, swales, diversion dikes, and on tidal or stream banks.

Materials:

New types of erosion control compost are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Material used within any TxDOT construction or maintenance activities must meet material specifications in accordance with current TxDOT specifications. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

ECC used for projects not related to TxDOT should also be of quality materials by meeting performance standards and compost specification data. To ensure the quality of compost used as an ECC, products should meet all applicable state and federal regulations, including but not limited to the United States Environmental Protection Agency (USEPA) Code of Federal Regulations (CFR), Title 40, Part 503 Standards for Class A biosolids and Texas Natural Resource Conservation Commission (now named TCEQ) Health and Safety Regulations as defined in the Texas Administration Code (TAC), Chapter 332, and all other relevant requirements for compost products outlined in TAC, Chapter 332. Testing requirements required by the TCEQ are defined in TAC Chapter 332, including Sections §332.71 Sampling and Analysis Requirements for Final Products and §332.72 Final Product Grades. Compost specification data approved by TxDOT are appropriate to use for ensuring the use of quality compost materials or for guidance.

Testing standards are dependent upon the intended use for the compost and ensures product safety, and product performance regarding the product's specific use. The appropriate compost sampling and testing protocols included in the United States Composting Council (USCC) Test Methods for the Examination of Composting and Compost (TMECC) should be conducted on compost products used for ECC to ensure that the products used will not impact public health, safety, and the environment and to promote production and marketing of quality composts that meet analytical standards. TMECC is a laboratory manual that provides protocols for the composting industry and test methods for compost analysis. TMECC provides protocols to sample, monitor, and analyze materials during all stages of the composting process. Numerous parameters that might be of concern in compost can be tested by following protocols or test methods listed in TMECC. TMECC information can be found at http://www.tmecc.org/tmecc/index.html. The USCC Seal of Testing Assurance (STA) program contains information regarding compost STA certification. STA program information can be found at http://tmecc.org/sta/STA_program_description.html.

Attachment 4
Description of BMPs

Installation:

- Install in accordance with current TxDOT specification.
- Use on slopes 3:1 or flatter.
- Apply a 2 inch uniform layer unless otherwise shown on the plans or as directed.
- When rolling is specified, use a light corrugated drum roller.

Mulch and Compost Filter Socks

Description: Mulch and compost filter socks (erosion control logs) are used to intercept and detain sediment laden run-off from unprotected areas. When properly used, mulch and compost filter socks can be highly effective at controlling sediment from disturbed areas. They cause runoff to pond which allows heavier solids to settle. Mulch and compost filter socks are used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. The sock should remain in place until the area is permanently stabilized. Mulch and compost filter socks may be installed in construction areas and temporarily moved during the day to allow construction activity provided it is replaced and properly anchored at the end of the day. Mulch and compost filter socks may be seeded to allow for quick vegetative growth and reduction in run-off velocity.

Materials:

New types of mulch and compost filter socks are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Mulch and compost filter socks used within any TxDOT construction or maintenance activities must meet material specifications in accordance with TxDOT specification 5049. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

Mulch and compost filter socks used for projects not related to TxDOT should also be of quality materials by meeting performance standards and compost specification data. To ensure the quality of compost used for mulch and compost filter socks, products should meet all applicable state and federal regulations, including but not limited to the United States Environmental Protection Agency (USEPA) Code of Federal Regulations (CFR), Title 40, Part 503 Standards for Class A biosolids and Texas Natural Resource Conservation Commission Health and Safety Regulations as defined in the Texas Administration Code (TAC), Chapter 332, and all other relevant requirements for compost products outlined in TAC, Chapter 332. Testing requirements required by the TCEQ are defined in TAC Chapter 332, including Sections §332.71 Sampling and Analysis Requirements for Final Products and §332.72 Final Product Grades. Compost specification data approved by TxDOT are appropriate to use for ensuring the use of quality compost materials or for guidance.

Testing standards are dependent upon the intended use for the compost and ensures product safety, and product performance regarding the product's specific use. The appropriate compost sampling and testing protocols included in the United States Composting Council (USCC) Test Methods for the Examination of Composting and Compost (TMECC) should be conducted on compost products used for mulch and compost filter socks to ensure that the products used will not impact public health, safety, and the environment and to promote production and marketing of quality composts that meet analytical standards. TMECC is a laboratory manual that provides protocols for the composting industry and test methods for compost analysis. TMECC provides protocols to sample, monitor, and analyze materials during all stages of the composting process. Numerous parameters that might be of concern in compost can be tested by following protocols or test methods listed in TMECC. TMECC information can be found at http://www.tmecc.org/tmecc/index.html. The USCC Seal of Testing Assurance (STA) program contains information regarding compost STA certification. STA program information can be found at http://tmecc.org/sta/STA_program_description.html.

Installation:

- Install in accordance with TxDOT Special Specification 5049.
- Install socks (erosion control logs) near the downstream perimeter of a disturbed area to intercept sediment from sheet flow.
- Secure socks in a method adequate to prevent displacement as a result of normal rain events such that flow is not allowed under the socks.
- Inspect and maintain the socks in good condition (including staking, anchoring, etc.). Maintain the integrity of the control, including keeping the socks free of accumulated silt, debris, etc., until the disturbed area has been adequately stabilized.

SEDIMENT CONTROL BMPS

Sand Bag Berm

Description: The purpose of a sandbag berm is to detain sediment carried in runoff from disturbed areas. This objective is accomplished by intercepting runoff and causing it to pool behind the sand bag berm. Sediment carried in the runoff is deposited on the upstream side of the sand bag berm due to the reduced flow velocity. Excess runoff volumes are allowed to flow over the top of the sand bag berm. Sand bag berms are used only during construction activities in streambeds when the contributing drainage area is between 5 and 10 acres and the slope is less than 15%, i.e., utility construction in channels, temporary channel crossing for construction equipment, etc. Plastic facing should be installed on the upstream side and the berm should be anchored to the streambed by drilling into the rock and driving in "T" posts or rebar (#5 or #6) spaced appropriately.

Attachment 4
Description of BMPs

Materials:

- The sand bag material should be polypropylene, polyethylene, polyamide or cotton burlap woven fabric, minimum unit weight 4 oz/yd 2, mullen burst strength exceeding 300 psi and ultraviolet stability exceeding 70 percent.
- The bag length should be 24 to 30 inches, width should be 16 to 18 inches and thickness should be 6 to 8 inches.
- Sandbags should be filled with coarse grade sand and free from deleterious material. All sand should pass through a No. 10 sieve. The filled bag should have an approximate weight of 40 pounds.
- Outlet pipe should be schedule 40 or stronger polyvinyl chloride (PVC) having a nominal internal diameter of 4 inches.

Installation:

- The berm should be a minimum height of 18 inches, measured from the top of the existing ground at the upslope toe to the top of the berm.
- The berm should be sized as shown in the plans but should have a minimum width of 48 inches measured at the bottom of the berm and 16 inches measured at the top of the berm.
- Runoff water should flow over the tops of the sandbags or through 4-inch diameter PVC pipes embedded below the top layer of bags.
- When a sandbag is filled with material, the open end of the sandbag should be stapled or tied with nylon or poly cord.
- Sandbags should be stacked in at least three rows abutting each other, and in staggered arrangement.
- The base of the berm should have at least 3 sandbags. These can be reduced to 2 and 1 bag in the second and third rows respectively.
- For each additional 6 inches of height, an additional sandbag must be added to each row width.
- A bypass pump-around system, or similar alternative, should be used on conjunction with the berm for effective dewatering of the work area.

Silt Fence

Description: A silt fence is a barrier consisting of geotextile fabric supported by metal posts to prevent soil and sediment loss from a site. When properly used, silt fences can be highly effective at controlling sediment from disturbed areas. They cause runoff to pond which allows heavier solids to settle. If not properly installed, silt fences are not likely to be effective. The purpose of a silt fence is to intercept and detain water-borne sediment from unprotected areas of a limited extent. Silt fence is used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. This fence should remain in place until the disturbed area is permanently stabilized. Silt fence should not be used where there is a concentration of water in a channel or drainage way. If concentrated flow occurs after installation, corrective action must be taken such as placing a rock berm in the areas of concentrated flow. Silt fencing within the site may be temporarily moved during the day to allow construction activity provided it is replaced and properly anchored to the ground at the end of the day. Silt fences on the perimeter of the site or around drainage ways should not be moved at any time.

Materials:

- Silt fence material should be polypropylene, polyethylene or polyamide woven or nonwoven fabric. The fabric width should be 36 inches, with a minimum unit weight of 4.5 oz/yd, mullen burst strength exceeding 190 lb/in 2, ultraviolet stability exceeding 70%, and minimum apparent opening size of U.S. Sieve No. 30.
- Fence posts should be made of hot rolled steel, at least 4 feet long with Tee or Y-bar cross section, surface painted or galvanized, minimum nominal weight 1.25 lb/ft 2, and Brindell hardness exceeding 140.
- Woven wire backing to support the fabric should be galvanized 2" x 4" welded wire, 12 gauge minimum.

Installation:

- Steel posts, which support the silt fence, should be installed on a slight angle toward the anticipated runoff source. Post must be embedded a minimum of 1 foot deep and spaced not more than 8 feet on center. Where water concentrates, the maximum spacing should be 6 feet.
- Lay out fencing down-slope of disturbed area, following the contour as closely as possible. The fence should be sited so that the maximum drainage area is ¼ acre/100 feet of fence.
- The toe of the silt fence should be trenched in with a spade or mechanical trencher, so that the down-slope face of the trench is flat and perpendicular to the line of flow. Where fence cannot be trenched in (e.g., pavement or rock outcrop), weight fabric flap with 3 inches of pea gravel on uphill side to prevent flow from seeping under fence.
- The trench must be a minimum of 6 inches deep and 6 inches wide to allow for the silt fence fabric to be laid in the ground and backfilled with compacted material.
- Silt fence should be securely fastened to each steel support post or to woven wire, which is in turn attached to the steel fence post. There should be a 3-foot overlap, securely fastened where ends of fabric meet.

Triangular Filter Dike

Description: The purpose of a triangular sediment filter dike is to intercept and detain water-borne sediment from unprotected areas of limited extent. The triangular sediment filter dike is used where there is no concentration of water in a channel or other drainage way above the barrier and the contributing drainage area is less than one acre. If the uphill slope above the dike exceeds 10%, the length of the slope above the dike should be less than 50 feet. If concentrated flow occurs after installation, corrective action should be taken such as placing rock berm in the areas of concentrated flow. This measure is effective on paved areas where installation of silt fence is not possible or where vehicle access must be maintained. The advantage of these controls is the ease with which they can be moved to allow vehicle traffic and then reinstalled to maintain sediment

Materials:

- Silt fence material should be polypropylene, polyethylene or polyamide woven or nonwoven fabric. The fabric width should be 36 inches, with a minimum unit weight of 4.5 oz/yd, mullen burst strength exceeding 190 lb/in 2 , ultraviolet stability exceeding 70%, and minimum apparent opening size of U.S. Sieve No. 30.

- The dike structure should be 6 gauge 6" x 6" wire mesh folded into triangular form being eighteen (18) inches on each side.

Installation:

- The frame of the triangular sediment filter dike should be constructed of 6" x 6", 6 gauge welded wire mesh, 18 inches per side, and wrapped with geotextile fabric the same composition as that used for silt fences.

- Filter material should lap over ends six (6) inches to cover dike to dike junction; each junction should be secured by shoat rings.

- Position dike parallel to the contours, with the end of each section closely abutting the adjacent sections.

- There are several options for fastening the filter dike to the ground. The fabric skirt may be toed-in with 6 inches of compacted material, or 12 inches of the fabric skirt should extend uphill and be secured with a minimum of 3 inches of open graded rock, or with staples or nails. If these two options are not feasible the dike structure may be trenched in 4 inches.

- Triangular sediment filter dikes should be installed across exposed slopes during construction with ends of the dike tied into existing grades to prevent failure and should intercept no more than one acre of runoff.

- When moved to allow vehicular access, the dikes should be reinstalled as soon as possible, but always at the end of the workday.

Rock Berm

Description: The purpose of a rock berm is to serve as a check dam in areas of concentrated flow, to intercept sediment-laden runoff, detain the sediment and release the water in sheet flow.

Attachment 4
Description of BMPs

The rock berm should be used when the contributing drainage area is less than 5 acres. Rock berms are used in areas where the volume of runoff is too great for a silt fence to contain. They are less effective for sediment removal than silt fences, particularly for fine particles, but are able to withstand higher flows than a silt fence. As such, rock berms are often used in areas of channel flows (ditches, gullies, etc.). Rock berms are most effective at reducing bed load in channels and should not be substituted for other erosion and sediment control measures further up the watershed.

Materials:

- The berm structure should be secured with a woven wire sheathing having maximum opening of 1 inch and a minimum wire diameter of 20 gauge galvanized and should be secured with shoat rings.
- Clean, open graded 3- to 5-inch diameter rock should be used, except in areas where high velocities or large volumes of flow are expected, where 5- to 8-inch diameter rocks may be used.

Installation:

- Lay out the woven wire sheathing perpendicular to the flow line. The sheathing should be 20 gauge woven wire mesh with 1 inch openings.
- Berm should have a top width of 2 feet minimum with side slopes being 2:1 (H:V) or flatter.
- Place the rock along the sheathing to a height not less than 18".
- Wrap the wire sheathing around the rock and secure with tie wire so that the ends of the sheathing overlap at least 2 inches, and the berm retains its shape when walked upon.
- Berm should be built along the contour at zero percent grade or as near as possible.
- The ends of the berm should be tied into existing upslope grade and the berm should be buried in a trench approximately 3 to 4 inches deep to prevent failure of the control.

Hay Bale Dike

Description: The purpose of a hay or straw bale dike is to intercept and detain small amounts of sediment-laden runoff from relatively small unprotected areas. Straw bales are to be used when it is not feasible to install other, more effective measures or when the construction phase is expected to last less than 3 months. Straw bales should not be used on areas where rock or other hard surfaces prevent the full and uniform anchoring of the barrier.

Materials:

Straw: The best quality straw mulch comes from wheat, oats or barley and should be free of weed and grass seed which may not be desired vegetation for the area to be protected. Straw mulch is light and therefore must be properly anchored to the ground.

Hay: This is very similar to straw with the exception that it is made of grasses and weeds and not grain stems. This form of mulch is very inexpensive and is widely available but does introduce weed and grass seed to the area. Like straw, hay is light and must be anchored.

- Straw bales should weigh a minimum of 50 pounds and should be at least 30 inches long.
- Bales should be composed entirely of vegetable matter and be free of seeds.
- Binding should be either wire or nylon string, jute or cotton binding is unacceptable. Bales should be used for not more than two months before being replaced.

Installation:

- Bales should be embedded a minimum of 4 inches and securely anchored using 2" x 2" wood stakes or 3/8" diameter rebar driven through the bales into the ground a minimum of 6 inches.
- Bales are to be placed directly adjacent to one another leaving no gap between them.
- All bales should be placed on the contour.
- The first stake in each bale should be angled toward the previously laid bale to force the bales together.

Brush Berms

Organic litter and spoil material from site clearing operations is usually burned or hauled away to be dumped elsewhere. Much of this material can be used effectively on the construction site itself. The key to constructing an efficient brush berm is in the method used to obtain and place the brush. It will not be acceptable to simply take a bulldozer and push whole trees into a pile. This method does not assure continuous ground contact with the berm and will allow uncontrolled flows under the berm.

Brush berms may be used where there is little or no concentration of water in a channel or other drainage way above the berm. The size of the drainage area should be no greater than one-fourth of an acre per 100 feet of barrier length; the maximum slope length behind the barrier should not exceed 100 feet; and the maximum slope gradient behind the barrier should be less than 50 percent (2:1).

Materials:

- The brush should consist of woody brush and branches, preferably less than 2 inches in diameter.
- The filter fabric should conform to the specifications for filter fence fabric.
- The rope should be ¼ inch polypropylene or nylon rope.

- The anchors should be 3/8-inch diameter rebar stakes that are 18-inches long.

Installation:

- Lay out the brush berm following the contour as closely as possible.
- The juniper limbs should be cut and hand placed with the vegetated part of the limb in close contact with the ground. Each subsequent branch should overlap the previous branch providing a shingle effect.
- The brush berm should be constructed in lifts with each layer extending the entire length of the berm before the next layer is started.
- A trench should be excavated 6-inches wide and 4-inches deep along the length of the barrier and immediately uphill from the barrier.
- The filter fabric should be cut into lengths sufficient to lay across the barrier from its up-slope base to just beyond its peak. The lengths of filter fabric should be draped across the width of the barrier with the uphill edge placed in the trench and the edges of adjacent pieces overlapping each other. Where joints are necessary, the fabric should be spliced together with a minimum 6-inch overlap and securely sealed.
- The trench should be backfilled and the soil compacted over the filter fabric.
- Set stakes into the ground along the downhill edge of the brush barrier, and anchor the fabric by tying rope from the fabric to the stakes. Drive the rope anchors into the ground at approximately a 45-degree angle to the ground on 6-foot centers.
- Fasten the rope to the anchors and tighten berm securely to the ground with a minimum tension of 50 pounds.
- The height of the brush berm should be a minimum of 24 inches after the securing ropes have been tightened.

Stone Outlet Sediment Traps

A stone outlet sediment trap is an impoundment created by the placement of an earthen and stone embankment to prevent soil and sediment loss from a site. The purpose of a sediment trap is to intercept sediment-laden runoff and trap the sediment in order to protect drainage ways, properties and rights of way below the sediment trap from sedimentation. A sediment trap is usually installed at points of discharge from disturbed areas. The drainage area for a sediment trap is recommended to be less than 5 acres.

Larger areas should be treated using a sediment basin. A sediment trap differs from a sediment basin mainly in the type of discharge structure. The trap should be located to obtain the maximum storage benefit from the terrain, for ease of clean out and disposal of the trapped sediment and to minimize interference with construction activities. The volume of the trap should be at least 3600 cubic feet per acre of drainage area.

Materials:

- All aggregate should be at least 3 inches in diameter and should not exceed a volume of 0.5 cubic foot.

- The geotextile fabric specification should be woven polypropylene, polyethylene or polyamide geotextile, minimum unit weight of 4.5 oz/yd 2, mullen burst strength at least 250 lb/in 2, ultraviolet stability exceeding 70%, and equivalent opening size exceeding 40.

Installation:

- Earth Embankment: Place fill material in layers not more than 8 inches in loose depth. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content of the material. Compact each layer to 95 percent standard proctor density. Do not place material on surfaces that are muddy or frozen. Side slopes for the embankment are to be 3:1. The minimum width of the embankment should be 3 feet.

- A gap is to be left in the embankment in the location where the natural confluence of runoff crosses the embankment line. The gap is to have a width in feet equal to 6 times the drainage area in acres.

- Geotextile Covered Rock Core: A core of filter stone having a minimum height of 1.5 feet and a minimum width at the base of 3 feet should be placed across the opening of the earth embankment and should be covered by geotextile fabric which should extend a minimum distance of 2 feet in either direction from the base of the filter stone core.

- Filter Stone Embankment: Filter stone should be placed over the geotextile and is to have a side slope which matches that of the earth embankment of 3:1 and should cover the geotextile/rock core a minimum of 6 inches when installation is complete. The crest of the outlet should be at least 1 foot below the top of the embankment.

Sediment Basins:

The purpose of a sediment basin is to intercept sediment-laden runoff and trap the sediment in order to protect drainage ways, properties and rights of way below the sediment basin from sedimentation. A sediment basin is usually installed at points of discharge from disturbed areas. The drainage area for a sediment basin is recommended to be less than 100 acres.

Sediment basins are effective for capturing and slowly releasing the runoff from larger disturbed areas thereby allowing sedimentation to take place. A sediment basin can be created where a permanent pond BMP is being constructed. Guidelines for construction of the permanent BMP should be followed, but revegetation, placement of underdrain piping, and installation of sand or other filter media should not be carried out until the site construction phase is complete.

Attachment 4
Description of BMPs

Materials:

- Riser should be corrugated metal or reinforced concrete pipe or box and should have watertight fittings or end to end connections of sections.
- An outlet pipe of corrugated metal or reinforced concrete should be attached to the riser and should have positive flow to a stabilized outlet on the downstream side of the embankment.
- An anti-vortex device and rubbish screen should be attached to the top of the riser and should be made of polyvinyl chloride or corrugated metal.

Basin Design and Construction:

- For common drainage locations that serve an area with ten or more acres disturbed at one time, a sediment basin should provide storage for a volume of runoff from a two-year, 24-hour storm from each disturbed acre drained.
- The basin length to width ratio should be at least 2:1 to improve trapping efficiency. The shape may be attained by excavation or the use of baffles. The lengths should be measured at the elevation of the riser de-watering hole.
- Place fill material in layers not more than 8 inches in loose depth. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content of the material. Compact each layer to 95 percent standard proctor density. Do not place material on surfaces that are muddy or frozen. Side slopes for the embankment should be 3:1 (H:V).
- An emergency spillway should be installed adjacent to the embankment on undisturbed soil and should be sized to carry the full amount of flow generated by a 10-year, 3-hour storm with 1 foot of freeboard less the amount which can be carried by the principal outlet control device.
- The emergency spillway should be lined with riprap as should the swale leading from the spillway to the normal watercourse at the base of the embankment.
- The principal outlet control device should consist of a rigid vertically oriented pipe or box of corrugated metal or reinforced concrete. Attached to this structure should be a horizontal pipe, which should extend through the embankment to the toe of fill to provide a de-watering outlet for the basin.
- An anti-vortex device should be attached to the inlet portion of the principal outlet control device to serve as a rubbish screen.
- A concrete base should be used to anchor the principal outlet control device and should be sized to provide a safety factor of 1.5 (downward forces = 1.5 buoyant forces).
- The basin should include a permanent stake to indicate the sediment level in the pool and marked to indicate when the sediment occupies 50% of the basin volume (not the top of the

stake).

- The top of the riser pipe should remain open and be guarded with a trash rack and anti-vortex device. The top of the riser should be 12 inches below the elevation of the emergency spillway. The riser should be sized to convey the runoff from the 2-year, 3-hour storm when the water surface is at the emergency spillway elevation. For basins with no spillway the riser must be sized to convey the runoff from the 10-yr, 3-hour storm.

- Anti-seep collars should be included when soil conditions or length of service make piping through the backfill a possibility.

- The 48-hour drawdown time will be achieved by using a riser pipe perforated at the point measured from the bottom of the riser pipe equal to ½ the volume of the basin. This is the maximum sediment storage elevation. The size of the perforation may be calculated as follows:

$$Ao = \frac{As \times \sqrt{2h}}{Cd \times 980{,}000}$$

Where:
A_o = Area of the de-watering hole, ft 2
A_s = Surface area of the basin, ft 2
C_d = Coefficient of contraction, approximately 0.6
h = head of water above the hole, ft
Perforating the riser with multiple holes with a combined surface area equal to A_o is acceptable.

Erosion Control Compost

Description: Erosion control compost (ECC) can be used as an aid to control erosion on critical sites during the establishment period of protective vegetation. The most common uses are on steep slopes, swales, diversion dikes, and on tidal or stream banks.

Materials:

New types of erosion control compost are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Material used within any TxDOT construction or maintenance activities must meet material specifications in accordance with current TxDOT specifications. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

ECC used for projects not related to TxDOT should also be of quality materials by meeting performance standards and compost specification data. To ensure the quality of compost used as an ECC, products should meet all applicable state and federal regulations, including but not limited to the United States Environmental Protection Agency (USEPA) Code of Federal Regulations (CFR), Title 40, Part 503 Standards for Class A biosolids and Texas Natural Resource Conservation Commission (now named TCEQ) Health and Safety Regulations as defined in the Texas Administration Code (TAC), Chapter 332, and all other relevant requirements for compost products outlined in TAC, Chapter 332. Testing requirements required by the TCEQ are defined in TAC Chapter 332, including Sections §332.71 Sampling and Analysis Requirements for Final Products and §332.72 Final Product Grades. Compost specification data approved by TxDOT are appropriate to use for ensuring the use of quality compost materials or for guidance.

Testing standards are dependent upon the intended use for the compost and ensures product safety, and product performance regarding the product's specific use. The appropriate compost sampling and testing protocols included in the United States Composting Council (USCC) Test Methods for the Examination of Composting and Compost (TMECC) should be conducted on compost products used for ECC to ensure that the products used will not impact public health, safety, and the environment and to promote production and marketing of quality composts that meet analytical standards. TMECC is a laboratory manual that provides protocols for the composting industry and test methods for compost analysis. TMECC provides protocols to sample, monitor, and analyze materials during all stages of the composting process. Numerous parameters that might be of concern in compost can be tested by following protocols or test methods listed in TMECC. TMECC information can be found at http://www.tmecc.org/tmecc/index.html. The USCC Seal of Testing Assurance (STA) program contains information regarding compost STA certification. STA program information can be found at http://tmecc.org/sta/STA_program_description.html.

Installation:

- Install in accordance with current TxDOT specification.
- Use on slopes 3:1 or flatter.
- Apply a 2 inch uniform layer unless otherwise shown on the plans or as directed.
- When rolling is specified, use a light corrugated drum roller.

Mulch and Compost Filter Socks

Description: Mulch and compost filter socks (erosion control logs) are used to intercept and detain sediment laden run-off from unprotected areas. When properly used, mulch and compost filter socks can be highly effective at controlling sediment from disturbed areas. They cause runoff to pond which allows heavier solids to settle. Mulch and compost filter socks are used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. The sock should remain in place until the area is permanently stabilized. Mulch and compost filter socks may be installed in construction areas and temporarily moved during the day to allow construction activity provided it is replaced and properly anchored at the end of the day. Mulch and compost filter socks may be seeded to allow for quick vegetative growth and reduction in run-off velocity.

Materials:

New types of mulch and compost filter socks are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Mulch and compost filter socks used within any TxDOT construction or maintenance activities must meet material specifications in accordance with TxDOT specification 5049. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

Mulch and compost filter socks used for projects not related to TxDOT should also be of quality materials by meeting performance standards and compost specification data. To ensure the quality of compost used for mulch and compost filter socks, products should meet all applicable state and federal regulations, including but not limited to the United States Environmental Protection Agency (USEPA) Code of Federal Regulations (CFR), Title 40, Part 503 Standards for Class A biosolids and Texas Natural Resource Conservation Commission Health and Safety Regulations as defined in the Texas Administration Code (TAC), Chapter 332, and all other relevant requirements for compost products outlined in TAC, Chapter 332. Testing requirements required by the TCEQ are defined in TAC Chapter 332, including Sections §332.71 Sampling and Analysis Requirements for Final Products and §332.72 Final Product Grades. Compost specification data approved by TxDOT are appropriate to use for ensuring the use of quality compost materials or for guidance.

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Installation:

- Install in accordance with TxDOT Special Specification 5049.

- Install socks (erosion control logs) near the downstream perimeter of a disturbed area to intercept sediment from sheet flow.
- Secure socks in a method adequate to prevent displacement as a result of normal rain events such that flow is not allowed under the socks.
- Inspect and maintain the socks in good condition (including staking, anchoring, etc.). Maintain the integrity of the control, including keeping the socks free of accumulated silt, debris, etc., until the disturbed area has been adequately stabilized.

POST-CONSTRUCTION TSS CONTROLS

Retention/Irrigation Systems

Description: Retention/irrigation systems refer to the capture of runoff in a holding pond, then use of the captured water for irrigation of appropriate landscape areas. Retention/irrigation systems are characterized by the capture and disposal of runoff without direct release of captured flow to receiving streams. Retention systems exhibit excellent pollutant removal but can require regular, proper maintenance. Collection of roof runoff for subsequent use (rainwater harvesting) also qualifies as a retention/irrigation practice, but should be operated and sized to provide adequate volume. This technology, which emphasizes beneficial use of stormwater runoff, is particularly appropriate for arid regions because of increasing demands on water supplies for agricultural irrigation and urban water supply.

Design Considerations: Retention/irrigation practices achieve 100% removal efficiency of total suspended solids contained within the volume of water captured. Design elements of retention/irrigation systems include runoff storage facility configuration and sizing, pump and wet well system components, basin lining, basin detention time, and physical and operational components of the irrigation system. Retention/irrigation systems are appropriate for large drainage areas with low to moderate slopes. The retention capacity should be sufficient considering the average rainfall event for the area.

Maintenance Requirements: Maintenance requirements for retention/irrigation systems include routine inspections, sediment removal, mowing, debris and litter removal, erosion control, and nuisance control.

Extended Detention Basin

Description: Extended detention facilities are basins that temporarily store a portion of stormwater runoff following a storm event. Extended detention basins are normally used to remove particulate pollutants and to reduce maximum runoff rates associated with development to their pre-development levels. The water quality benefits are the removal of sediment and buoyant materials. Furthermore, nutrients, heavy metals, toxic materials, and oxygen-demanding materials associated with the particles also are removed. The control of the maximum runoff rates serves to protect drainage channels below the device from erosion and to reduce downstream flooding. Although detention facilities designed for flood control have different design requirements than those used for water quality enhancement, it is possible to achieve these two objectives in a single facility.

Design Considerations: Extended detention basins can remove approximately 75% of the total suspended solids contained within the volume of runoff captured in the basin. Design elements of extended detention basins include basin sizing, basin configuration, basin side slopes, basin lining, inlet/outlet structures, and erosion controls. Extended detention basins are appropriate for large drainage areas with low to moderate slopes. The retention capacity should be sufficient considering the average rainfall event for the area.

Maintenance Requirements: Maintenance requirements for extended detention basins include routine inspections, mowing, debris and litter removal, erosion control, structural repairs, nuisance control, and sediment removal.

Vegetative Filter Strips

Description: Filter strips, also known as vegetated buffer strips, are vegetated sections of land similar to grassy swales except they are essentially flat with low slopes, and are designed only to accept runoff as overland sheet flow. They may appear in any vegetated form from grassland to forest, and are designed to intercept upstream flow, lower flow velocity, and spread water out as sheet flow. The dense vegetative cover facilitates conventional pollutant removal through detention, filtration by vegetation, and infiltration.

Filter strips cannot treat high velocity flows, and do not provide enough storage or infiltration to effectively reduce peak discharges to predevelopment levels for design storms. This lack of quantity control favors use in rural or low-density development; however, they can provide water quality benefits even where the impervious cover is as high as 50%. The primary highway application for vegetative filter strips is along rural roadways where runoff that would otherwise discharge directly to a receiving water passes through the filter strip before entering a conveyance system. Properly designed roadway medians and shoulders make effective buffer strips. These devices also can be used on other types of development where land is available and hydraulic conditions are appropriate.

Flat slopes and low to fair permeability of natural subsoil are required for effective performance of filter strips. Although an inexpensive control measure, they are most useful in contributing watershed areas where peak runoff velocities are low as they are unable to treat the high flow velocities typically associated with high impervious cover.

Successful performance of filter strips relies heavily on maintaining shallow unconcentrated flow. To avoid flow channelization and maintain performance, a filter strip should:

- Be equipped with a level spreading device for even distribution of runoff
- Contain dense vegetation with a mix of erosion resistant, soil binding species
- Be graded to a uniform, even and relatively low slope
- Laterally traverse the contributing runoff area

Attachment 4
Description of BMPs

Filter strips can be used upgradient from watercourses, wetlands, or other water bodies along toes and tops of slopes and at outlets of other stormwater management structures. They should be incorporated into street drainage and master drainage planning. The most important criteria for selection and use of this BMP are soils, space, and slope.

Design Considerations: Vegetative filter strips can remove approximately 85% of the total suspended solids contained within the volume of runoff captured. Design elements of vegetative filter strips include uniform, shallow overland flow across the entire filter strip area, hydraulic loading rate, inlet structures, slope, and vegetative cover. The area should be free of gullies or rills which can concentrate flow. Vegetative filter strips are appropriate for small drainage areas with moderate slopes. Other design elements include the following:

- Soils and moisture are adequate to grow relatively dense vegetative stands
- Sufficient space is available
- Slope is less than 12%
- Comparable performance to more expensive structural controls

Maintenance Requirements: Maintenance requirements for vegetative filter strips include pest management, seasonal mowing and lawn care, routine inspections, debris and litter removal, sediment removal, and grass reseeding and mulching.

Constructed Wetlands

Description: Constructed wetlands provide physical, chemical, and biological water quality treatment of stormwater runoff. Physical treatment occurs as a result of decreasing flow velocities in the wetland, and is present in the form of evaporation, sedimentation, adsorption, and/or filtration. Chemical processes include chelation, precipitation, and chemical adsorption. Biological processes include decomposition, plant uptake and removal of nutrients, plus biological transformation and degradation. Hydrology is one of the most influential factors in pollutant removal due to its effects on sedimentation, aeration, biological transformation, and adsorption onto bottom sediments.

The wetland should be designed such that a minimum amount of maintenance is required. The natural surroundings, including such things as the potential energy of a stream or flooding river, should be utilized as much as possible. The wetland should approximate a natural situation and unnatural attributes, such as rectangular shape or rigid channel, should be avoided.

Site considerations should include the water table depth, soil/substrate, and space requirements. Because the wetland must have a source of flow, it is desirable that the water table is at or near the surface. If runoff is the only source of inflow for the wetland, the water level often fluctuates and establishment of vegetation may be difficult. The soil or substrate of an artificial wetland should be loose loam to clay. A perennial baseflow must be present to sustain the artificial wetland. The presence of organic material is often helpful in increasing pollutant removal and retention. A greater amount of space is required for a wetland system than is required for a detention facility treating the same amount of area.

Design Considerations: Constructed wetlands can remove over 90% of the total suspended solids contained within the volume of runoff captured in the wetland. Design elements of constructed wetlands include wetland sizing, wetland configuration, sediment forebay, vegetation, outflow structure, depth of inundation during storm events, depth of micropools, and aeration. Constructed wetlands are appropriate for large drainage areas with low to moderate slopes.

Maintenance Requirements: Maintenance requirements for constructed wetlands include mowing, routine inspections, debris and litter removal, erosion control, nuisance control, structural repairs, sediment removal, harvesting, and maintenance of water levels.

Wet Basins

Description: Wet basins are runoff control facilities that maintain a permanent wet pool and a standing crop of emergent littoral vegetation. These facilities may vary in appearance from natural ponds to enlarged, bermed (manmade) sections of drainage systems and may function as online or offline facilities, although offline configuration is preferable. Offline designs can prevent scour and other damage to the wet pond and minimize costly outflow structure elements needed to accommodate extreme runoff events.

During storm events, runoff inflows displace part or all of the existing basin volume and are retained and treated in the facility until the next storm event. The pollutant removal mechanisms are settling of solids, wetland plant uptake, and microbial degradation. When the wet basin is adequately sized, pollutant removal performance can be excellent, especially for the dissolved fraction. Wet basins also help provide erosion protection for the receiving channel by limiting peak flows during larger storm events. Wet basins are often perceived as a positive aesthetic element in a community and offer significant opportunity for creative pond configuration and landscape design. Participation of an experienced wetland designer is suggested. A significant potential drawback for wet ponds in arid climates is that the contributing watershed for these facilities is often incapable of providing an adequate water supply to maintain the permanent pool, especially during the summer months. Makeup water (i.e., well water or municipal drinking water) is sometimes used to supplement the rainfall/runoff process, especially for wet basin facilities treating watersheds that generate insufficient runoff.

Design Considerations: Wet basins can remove over 90% of the total suspended solids contained within the volume of runoff captured in the basin. Design elements of wet basins include basin sizing, basin configuration, basin side slopes, sediment forebay, inflow and outflow structures, vegetation, depth of permanent pool, aeration, and erosion control. Wet basins are appropriate for large drainage areas with low to moderate slopes.

Maintenance Requirements: Maintenance requirements for wet basins include mowing, routine inspections, debris and litter removal, erosion control, nuisance control, structural repairs, sediment removal, and harvesting.

Attachment 4
Description of BMPs

Grassy Swales

Grassy swales are vegetated channels that convey stormwater and remove pollutants by filtration through grass and infiltration through soil. They require shallow slopes and soils that drain well. Pollutant removal capability is related to channel dimensions, longitudinal slope, and type of vegetation. Optimum design of these components will increase contact time of runoff through the swale and improve pollutant removal rates.

Grassy swales are primarily stormwater conveyance systems. They can provide sufficient control under light to moderate runoff conditions, but their ability to control large storms is limited. Therefore, they are most applicable in low to moderate sloped areas or along highway medians as an alternative to ditches and curb and gutter drainage. Their performance diminishes sharply in highly urbanized settings, and they are generally not effective enough to receive construction stage runoff where high sediment loads can overwhelm the system. Grassy swales can be used as a pretreatment measure for other downstream BMPs, such as extended detention basins. Enhanced grassy swales utilize check dams and wide depressions to increase runoff storage and promote greater settling of pollutants.

Grassy swales can be more aesthetically pleasing than concrete or rock-lined drainage systems and are generally less expensive to construct and maintain. Swales can slightly reduce impervious area and reduce the pollutant accumulation and delivery associated with curbs and gutters. The disadvantages of this technique include the possibility of erosion and channelization over time, and the need for more right-of-way as compared to a storm drain system. When properly constructed, inspected, and maintained, the life expectancy of a swale is estimated to be 20 years.

Design Considerations:

- Comparable performance to wet basins
- Limited to treating a few acres
- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

The suitability of a swale at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the swale system. In general, swales can be used to serve areas of less than 10 acres, with slopes no greater than 5 %. The seasonal high water table should be at least 4 feet below the surface. Use of natural topographic lows is encouraged, and natural drainage courses should be regarded as significant local resources to be kept in use.

Maintenance Requirements:

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

Attachment 4
Description of BMPs

Vegetation Lined Drainage Ditches

Vegetation lined drainage ditches are similar to grassy swales. These drainage ditches are vegetated channels that convey storm water and remove pollutants by filtration through grass and infiltration through soil. They require soils that drain well. Pollutant removal capability is related to channel dimensions, longitudinal slope, and type of vegetation. Optimum design of these components will increase contact time of runoff through the ditch and improve pollutant removal rates. Vegetation lined drainage ditches are primarily storm water conveyance systems. They have vegetation lined in the low flow channel and may include vegetated shelves.

Vegetation in drainage ditches reduces erosion and removes pollutants by lowering water velocity over the soil surface, binding soil particles with roots, and by filtration through grass and infiltration through soil. Vegetation lined drainage ditches can be used where:

- A vegetative lining can provide sufficient stability for the channel grade by increasing maximum permissible velocity

- Slopes are generally less than 5%, with protection from sheer stress as needed through the use of BMPs, such as erosion control blankets

- Site conditions required to establish vegetation, i.e. climate, soils, topography, are present

Design Criteria: The suitability of a vegetation lined drainage ditch at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the ditch system. The hydraulic capacity of the drainage ditch and other elements such as erosion, siltation, and pollutant removal capability, must be taken into consideration. Use of natural topographic lows is encouraged, and natural drainage courses should be regarded as significant local resources to be kept in use. Other items to consider include the following:

- Capacity, cross-section shape, side slopes, and grade

- Select appropriate native vegetation

- Construct in stable, low areas to conform with the natural drainage system. To reduce erosion potential, design the channel to avoid sharp bends and steep grades.

- Design and build drainage ditches with appropriate scour and erosion protection. Surface water should be able to enter over the vegetated banks without erosion occurring.

- BMPs, such as erosion control blankets, may need to be installed at the time of seeding to provide stability until the vegetation is fully established. It may also be necessary to divert water from the channel until vegetation is established or to line the channel with sod.

- Vegetated ditches must not be subject to sedimentation from disturbed areas.

• Sediment traps may be needed at channel inlets to prevent entry of muddy runoff and channel sedimentation.

- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

Maintenance:

During establishment, vegetation lined drainage ditches should be inspected, repaired, and vegetation reestablished if necessary. After the vegetation has become established, the ditch should be checked periodically to determine if the channel is withstanding flow velocities without damage. Check the ditch for debris, scour, or erosion and immediately make repairs if needed. Check the channel outlet and all road crossings for bank stability and evidence of piping or scour holes and make repairs immediately. Remove all significant sediment accumulations to maintain the designed carrying capacity. Keep the vegetation in a healthy condition at all times, since it is the primary erosion protection for the channel. Vegetation lined drainage ditches should be seasonally maintained by mowing or irrigating, depending on the vegetation selected. The long-term management of ditches as stable, vegetated, "natural" drainage systems with native vegetation buffers is highly recommended due to the inherent stability offered by grasses, shrubs, trees, and other vegetation.

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

Sand Filter Systems

The objective of sand filters is to remove sediment and the pollutants from the first flush of pavement and impervious area runoff. The filtration of nutrients, organics, and coliform bacteria is enhanced by a mat of bacterial slime that develops during normal operations. One of the main advantages of sand filters is their adaptability; they can be used on areas with thin soils, high evaporation rates, low-soil infiltration rates, in limited-space areas, and where groundwater is to be protected.

Since their original inception in Austin, Texas, hundreds of intermittent sand filters have been implemented to treat stormwater runoff. There have been numerous alterations or variations in the original design as engineers in other jurisdictions have improved and adapted the technology to meet their specific requirements. Major types include the Austin Sand Filter, the District of Columbia Underground Sand Filter, the Alexandria Dry Vault Sand Filter, the Delaware Sand Filter, and peat-sand filters which are adapted to provide a sorption layer and vegetative cover to various sand filter designs .

Design Considerations:

- Appropriate for space-limited areas

- Applicable in arid climates where wet basins and constructed wetlands are not appropriate
- High TSS removal efficiency

Cost Considerations:

Filtration Systems may require less land than some other BMPs, reducing the land acquisition cost; however the structure itself is one of the more expensive BMPs. In addition, maintenance cost can be substantial.

Erosion Control Compost

Description: Erosion control compost (ECC) can be used as an aid to control erosion on critical sites during the establishment period of protective vegetation. The most common uses are on steep slopes, swales, diversion dikes, and on tidal or stream banks.

Materials:

New types of erosion control compost are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Material used within any TxDOT construction or maintenance activities must meet material specifications in accordance with current TxDOT specifications. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

ECC used for projects not related to TxDOT should also be of quality materials by meeting performance standards and compost specification data. To ensure the quality of compost used as an ECC, products should meet all applicable state and federal regulations, including but not limited to the United States Environmental Protection Agency (USEPA) Code of Federal Regulations (CFR), Title 40, Part 503 Standards for Class A biosolids and Texas Natural Resource Conservation Commission (now named TCEQ) Health and Safety Regulations as defined in the Texas Administration Code (TAC), Chapter 332, and all other relevant requirements for compost products outlined in TAC, Chapter 332. Testing requirements required by the TCEQ are defined in TAC Chapter 332, including Sections §332.71 Sampling and Analysis Requirements for Final Products and §332.72 Final Product Grades. Compost specification data approved by TxDOT are appropriate to use for ensuring the use of quality compost materials or for guidance.
Testing standards are dependent upon the intended use for the compost and ensures product safety, and product performance regarding the product's specific use. The appropriate compost sampling and testing protocols included in the United States Composting Council (USCC) Test Methods for the Examination of Composting and Compost (TMECC) should be conducted on compost products used for ECC to ensure that the products used will not impact public health, safety, and the environment and to promote production and marketing of quality composts that meet analytical standards. TMECC is a laboratory manual that provides protocols for the composting industry and test methods for compost analysis. TMECC provides protocols to sample, monitor, and analyze materials during all stages of the composting process. Numerous

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Installation:

- Install in accordance with current TxDOT specification.
- Use on slopes 3:1 or flatter.
- Apply a 2 inch uniform layer unless otherwise shown on the plans or as directed.
- When rolling is specified, use a light corrugated drum roller.

Mulch and Compost Filter Socks

Description: Mulch and compost filter socks (erosion control logs) are used to intercept and detain sediment laden run-off from unprotected areas. When properly used, mulch and compost filter socks can be highly effective at controlling sediment from disturbed areas. They cause runoff to pond which allows heavier solids to settle. Mulch and compost filter socks are used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. The sock should remain in place until the area is permanently stabilized. Mulch and compost filter socks may be installed in construction areas and temporarily moved during the day to allow construction activity provided it is replaced and properly anchored at the end of the day. Mulch and compost filter socks may be seeded to allow for quick vegetative growth and reduction in run-off velocity.

Materials:

New types of mulch and compost filter socks are continuously being developed. The Texas Department of Transportation (TxDOT) has established minimum performance standards which must be met for any products seeking to be approved for use within any of TxDOT's construction or maintenance activities. Mulch and compost filter socks used within any TxDOT construction or maintenance activities must meet material specifications in accordance with TxDOT specification 5049. TxDOT maintains a website at http://www.txdot.gov/business/contractors_consultants/recycling/compost.htm that provides information on compost specification data.

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Installation:

- Install in accordance with TxDOT Special Specification 5049.
- Install socks (erosion control logs) near the downstream perimeter of a disturbed area to intercept sediment from sheet flow.
- Secure socks in a method adequate to prevent displacement as a result of normal rain events such that flow is not allowed under the socks.
- Inspect and maintain the socks in good condition (including staking, anchoring, etc.). Maintain the integrity of the control, including keeping the socks free of accumulated silt, debris, etc., until the disturbed area has been adequately stabilized.

Sedimentation Chambers (only to be used when there is no space available for other approved BMP's)

Description: Sedimentation chambers are stormwater treatment structures that can be used when space is limited such as urban settings. These structures are often tied into stormwater drainage systems for treatment of stormwater prior to entering state waters. The water quality benefits are the removal of sediment and buoyant materials. These structures are not designed as a catch basin or detention basin and not typically used for floodwater attenuation.

Design Considerations: Average rainfall and surface area should be considered when following manufacturer's recommendations for chamber sizing and/or number of units needed to achieve effective TSS removal. If properly sized, 50-80% removal of TSS can be expected.

Attachment 4
Description of BMPs

Maintenance Requirements: Maintenance requirements include routine inspections, sediment, debris and litter removal, erosion control and nuisance control.

PERMIT COMPLIANCE CERTIFICATION

U.S. Army Corps of Engineers Project Number:

Permit Number:

Name of Permittee:

Date of Issuance:

Upon completion of the activity authorized by this permit and any mitigation required by the permit, sign this certification and return it to the following address:

Regulatory Branch
CESWF-PER-R
U.S. Army Corps of Engineers
P.O. Box 17300
Fort Worth, Texas 76102-0300

Please note that your permitted activity is subject to a compliance inspection by a U.S. Army Corps of Engineers representative. If you fail to comply with this permit you are subject to permit suspension, modification, or revocation.

I hereby certify that the work authorized by the above referenced permit was completed in accordance with the terms and conditions of the said permit, and required mitigation was completed in accordance with the permit conditions.

____
Signature of Permittee

____
Date

(*No document text on this page*)

Signed General Draft EA Letters
(Letters will be inserted once signed)

Signed Tribal Draft EA Letters
(Letters will be inserted once signed)

Final Draft EA IICEP Mailing List

DEA IICEP Mailing List
Environmental Assessment for Growdon Gate/Road Relocation and Property Acquisition
Joint Base San Antonio-Lackland, Texas
18 September 2012

Agency	**Department**	**Title**	**Name**	**Last Name**	**Address**	**City**	**State**	**Zip Code**
USEPA	Region 6	Administrator	Lisa	Jackson	1445 Ross Avenue, Suite 1200	Dallas	TX	75202
U.S. Fish and Wildlife Service		Field Supervisor	David	Frederick	10711 Burnet Road, Suite 200	Austin	TX	78758-4460
U.S. Army Corps of Engineers	Regulatory Branch, Permit Section	Project Manager	Federick	Land	Attn: CESWF-PER-R P.O. Box 17300	Fort Worth	TX	76102-0300
TCEQ	Office of Permitting and Registration	Deputy Director	Richard	Hyde	MC 122 P.O. Box 13087	Austin	TX	78711-3087
State Historical Commision	State Historic Preservation Office		F. Lawrence	Oaks	P.O Box 12276	Austin	TX	78711-2276
TRACs		Single Point of Contact	Denise	Francis	P.O. Box 12428 Room 441-A	Austin	TX	78711-2428
FEMA			Kyle	Mills	800 North Loop 288	Denton	TX	76209
Bexar County	FPA		Diane	Bartlett	233 North Pecos Street, Suite 420	San Antonio	TX	78207
Texas Water Development Board		NFIP State Coordinator	Michael	Segner, CFM	P.O. Box 13231	Austin	TX	78711-3231
AACOG		Community Relations Coordinator	Tiffany	Pickens	8700 Tesoro Drive, Suite 700	San Antonio	TX	78217-6228
TPWD	Ecosystem/Habitat Assessment Branch	Chief	David	Sager	4200 Smith School Road	Austin	TX	78744-3291
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Mescalero Apache and Affiliated Tribes		President	Mark	Chino	P.O. Box 227	Mescalero	NM	88340

Notice of Availability of the Draft EA
(Notice will be inserted once submitted to newspaper for publication)

(*No document text on this page*)

Appendix B

Biological Assessment/Evaluation for Road and Gate Construction at Lackland Air Force Base, Texas

FINAL

BIOLOGICAL ASSESSMENT/EVALUATION FOR ROAD AND GATE CONSTRUCTION AT LACKLAND AIR FORCE BASE, TEXAS

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EXECUTIVE SUMMARY

Introduction

The proposed project involves acquiring private land, building an access road on the new land, and relocation of the main gate (Growdon Gate) at Lackland Air Force Base (LAFB) in San Antonio, Texas. Two road alignment alternatives are proposed: Proposed Action would be to relocate the Growdon Gate and the Commercial Vehicle Inspection Area east of the Leon Creek Flood Zone Property. In addition, an access road would be built east of the Leon Creek Flood Zone Property. Alternative 1 would be to relocate the Growdon Gate and the Commercial Vehicle Inspection Area farther west so that Growdon Gate is located south of United States (U.S.) Highway 90 and the Guard Shack north of Leon Creek. In this alternative, a new access road to the gate would be built across the Leon Creek Flood Zone Property. Alternative 2 would be to relocate the Growdon Gate and the Commercial Vehicle Inspection Area farther west so that Growdon Gate is located south of United States (U.S.) Highway 90 and the Guard Shack south of Leon Creek. In this alternative, a new access road to the gate would also be built across the Leon Creek Flood Zone Property.

Habitat Assessment and Presence/Absence Surveys

Endangered, threatened, candidate and species of concern habitat assessments and surveys were conducted within the proposed project corridors for both of the project alternatives. Potential occurrence of listed species was determined by comparing habitat requirements of the listed species with habitats present within each project corridor. A habitat ground-truth survey was completed to verify the suitability of habitats within each project corridor to support potentially occurring listed species. Additionally, visual presence/absence surveys were conducted for those all terrestrial and emergent aquatic listed species

Results

<u>Federally Listed Species</u>

Project activity would not result in adverse impacts to federally listed species or their critical habitat in either of the potential project alternative sites.

<u>Bald and Golden Eagles</u>

It is unlikely that either eagle species would be adversely affected by selection of the potential project alternatives.

<u>Migratory Birds</u>

The riparian wetland habitat provides breeding sites for several birds, listed by the Migratory Bird Treaty Act (MBTA), within the road corridor proposed under Alternative 1 and Alterntive 2. To mitigate the potential loss of migratory bird nests during construction, it is recommended that construction clearing activities be scheduled for the non-breeding months (August through January). The Proposed Action is located primarily outside of the riparian habitat along Leon Creek and would have a negligible effect on breeding MBTA species. The riparian wetland habitat along Leon Creek also has the potential to provide foraging and resting habitat for migratory birds. A small amount of this suitable foraging habitat would be lost and fragmented by the Alternative 1 and Alternative 2 routes through riparian wetlands. In addition, all standard construction best management practices would be used to protect adjacent habitat from degradation and contamination. Overall, with the recommended mitigation, the project alternatives should not adversely affect the population of any occurring migratory bird species.

Birds of Conservation Concern

Curve-billed thrasher was the only bird of conservation of concern observed during the surveys. Construction of either alternative would result in a minimal loss of suitable breeding habitat. As a result, habitat loss due to project construction to migratory birds of conservation of concern may not adversely affect all of the potentially occurring birds of conservation concern.

State-Listed Species

Based on the habitat assessment, suitable habitat exists for 14 of the 36 state-listed threatened and endangered species and species of concern listed for Bexar County. These species would not likely be adversely affected by the selection of either project alternative because of the small area of potentially suitable habitat affected by the project, the scarcity of their occurrence in the region, and conservation measures that would be implemented during the Proposed Action.

Summary

Based on the habitat suitability analysis, on-site surveys, occurrence data for the region, and conservation measures, federal- and state-listed species potentially occurring in the selected project alternative are not likely to be adversely affected by the Proposed Action.

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LIST OF ACRONYMS AND ABBREVIATIONS

°F	Degree(s) Fahrenheit
BA	Biological Assessment
BAE	Biological Assessment and Evaluation
BCP	Birds of Conservation Concern Program
BCR	Bird Conservation Region
C	Candidate
CCP	Candidate Conservation Program
CFR	Code of Federal Regulations
CVIC	Commercial Vehicle Inspection Center
DL	Delisted
DoD	Department of Defense
E	Endangered
EA	Environmental Assessment
EO	Executive Order
ESA	Endangered Species Act
FR	Federal Register
ft	Foot (Feet)
GMI	Geo-Marine, Inc.
LAFB	Lackland Air Force Base
LE	Listed Endangered
MBTA	Migratory Bird Treaty Act
mi	mile(s)
MOU	Memorandum of Understanding
NL	Not Listed
NTMB	Neotropical Migratory Bird
NWS	National Weather Service
P.L.	Public Law
R	Resident
SA	Similarity of Appearance
SOC	Species of Concern
T	Threatened
TPWD	Texas Parks and Wildlife Department
U	Unknown
U.S.	United States
U.S.C.	United States Code
USFWS	United States Fish and Wildlife Service

1.0 INTRODUCTION

1.1 Proposed Project

The proposed project involves Lackland Air Force Base (LAFB) acquiring land, building an access road on the new land and relocating the Growdon Gate and Commercial Vehicle Inspection Center (CVIC). Weston Solutions, Inc. (Weston) has contracted Geo-Marine, Inc. (GMI) to prepare a Biological Assessment and Evaluation (BAE) for threatened, endangered, candidate, and species of concern (listed species) that may occur on land that would potentially be impacted by road and gate construction.

1.2 Purpose and Need

The BAE is prepared in accordance with principal law governing endangered species, the Endangered Species Act (ESA) of 1973. The purpose of a biological assessment (BA), as stated in 50 Code of Federal Regulations (CFR) Part 402, Section 402.12 of the ESA is to "evaluate the potential effects of the action on listed and proposed species and designated and proposed critical habitat and determine whether any species or habitat are likely to be adversely affected by the action".

This BAE is intended to aid the United States Fish and Wildlife Service (USFWS) in determining whether the proposed project alternatives are likely to adversely affect listed species or designated critical habitat. This BAE is necessary to ensure that early involvement by USFWS will increase the chances for resolution of any concerns identified in development of the environmental assessment (EA) and subsequently during informal consultation with the USFWS.

2.0 PROPOSED ACTION

The proposed action will be to acquire land, construct an access road on the new property, and relocate the Growdon Gate and the CVIC area. Two alternatives are being evaluated in addition to the Proposed Action.

2.1 Proposed Action (Preferred)

Proposed Action will be to acquire land, construct an access road around Leon Creek to the east, and relocate the Growdon Gate and the Commercial Vehicle Inspection Area to the south of United States (U.S.) Highway 90 (**Figure 2-1**). The new access road will be approximately 2.04 miles (mi) long and 100 feet (ft) wide. Approximately 16.48 acres of land would be cleared during road construction. The new entry gate would approximately require 4.73 acres of land to be cleared.

2.2 Alternative 1

Alternative 1 will consist of the same land acquisition; however, the new access road will be built across Leon Creek and flood zone property and the gate will be located at the north end of the new road (**Figure 2-2**). The new road will be approximately 1.34 mi long and 100 ft wide; approximately 24.84 acres of land would be cleared during road construction. The new entry gate would require approximately 4.73 acres of land to be cleared.

Figure 2-1. Map showing location of Proposed Action.

Figure 2-2. Map showing location of Proposed Alternative 1.

2.3 Alternative 2

Alternative 2 mirrors the road alignment of Alternative 1; however, the new gate is located at the south end of the road (**Figure 2-3**). Approximately the same number of acres will be cleared as Alternative 1.

3.0 RELEVANT REGULATIONS

3.1 Federal

3.1.1 Endangered Species Act

The ESA of 1973 (Public Law [P.L.] 93-205 and amendments of 1988 [P.L. 100-478]) was enacted to provide a program of preservation for endangered and threatened species and to provide protection for ecosystems upon which species depend for their survival. An endangered species is a species that is in danger of extinction throughout all or a significant portion of its range. A threatened species is a species likely to become endangered within the foreseeable future throughout all or a significant portion of its range. It is unlawful to import or export, take, harass, harm, possess, sell, deliver, carry, transport, ship, receive, buy, sell, or offer to sell any listed species, or violate any other regulation pertaining to endangered or threatened species (Federal Wildlife Laws Handbook 2005a). Species proposed for listing are those species that have been formally submitted to Congress for official listing as endangered or threatened. Implementation of the ESA with reference to endangered and threatened species is the responsibility of the USFWS.

The USFWS also has a Candidate Conservation Program (CCP). Candidate species are those for which the USFWS has sufficient information, based on their biological status and threats, to propose for listing as either endangered or threatened under the ESA. Although candidate species have no protection under law, the USFWS has identified these species to provide shareholders the opportunity to manage these species with the goal of preventing their listing as threatened or endangered species (USFWS 2005).

3.1.2 Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (16 U.S. Code [U.S.C.] 668-668d of 1940 and the amendments of 1959, 1962, 1972, and 1978) was enacted to protect America's national symbol, the bald eagle (*Haliaeetus leucocephalus*). The golden eagle (*Aquila chrysaetos*) is a similar-appearing eagle, especially in immature life stages, and therefore was added to ensure protection of the bald eagle. The act prohibits, except as stated, the taking, possessing, selling, purchasing, bartering, transporting, exporting, or importing any bald or golden eagle at any time (Federal Wildlife Laws Handbook 2005b).

The bald eagle was proposed to be removed (delisted) from the List of Endangered and Threatened Wildlife in 1999 (Federal Register [FR] 64 [128]). Removal was delayed until protections and management guidelines were developed by the USFWS; however, all guidelines have been established and on June 28, 2008 the bald eagle was delisted. The bald eagle is now protected and managed by the Bald and Golden Eagle Protection Act and the specified regulations are listed below.

Figure 2-3. Map showing location of Proposed Alternative 2.

The USFWS recently clarified protection of eagles by publishing a rule (50 CFR Part 22) that defines disturbance to eagles as "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information (1) injury to the eagle, (2) a decrease in its productivity by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment." In addition, the USFWS has published a new rule relating to the protection of eagles and national bald eagle management guidelines, including authorizations under the Bald and Golden Eagle Protection Act for the take of eagles (50 CFR Part 13 and 22).

3.1.3 Other Acts, Conventions, and Executive Orders

The Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703-712) authorizes the U.S. commitment to comply with international conventions (i.e., with Japan, Russia, Canada, and Mexico) for the protection of migratory bird resources. The conventions protect selected species of migratory birds that occur in the U.S. and each country at some time during the annual life cycle of the species. All selected migratory birds and their parts (including nests, eggs, and feathers) are fully protected under the MBTA (Department of Defense [DoD] [2005]; Federal Wildlife Laws Handbook [2005c]).

Executive Order (EO) 13186, Responsibilities of Federal Agencies to Protect Migratory birds, was signed by the President in 2001. The EO directs executive department and agencies to take further actions to implement the MBTA. The primary federal agency responsibility directed by the EO is to develop a Memorandum of Understanding (MOU) with the USFWS to promote the conservation of migratory bird populations.

3.1.4 Migratory Bird Conservation Programs

In order to comply with legal mandates related to the protection of migratory birds, the USFWS developed several federal management programs, including the birds of conservation concern program (BCP). The BCP identifies migratory and non-migratory bird species, other than those listed under the ESA as endangered or threatened that are of high conservation priority and need conservation management action (USFWS 2008).

Non-game birds, game birds without hunting seasons, subsistence-hunted non-game birds in Alaska, ESA candidates, proposed endangered and threatened species, and recently delisted species were considered for the birds of conservation concern list. Assessment scores from three major conservation plans, Partners in Flight, the U.S. Shorebird Conservation Plan, and the North American Waterbird Conservation Plan, were evaluated to develop the birds of conservation concern list. The USFWS divided the continental U.S. into 34 Bird Conservation Regions (BCRs) and developed specific birds of conservation lists for each BCR.

3.2 State

State laws and regulations for threatened and endangered species are located in Chapters 67 and 68 of the Texas Parks and Wildlife Code and Sections 65-18 and 65-171 of Title 31 of the Texas Administrative Code. Texas Parks and Wildlife Department (TPWD) regulations prohibit the taking, possession, transportation, or sale of any species listed as threatened or endangered in the state. TPWD investigates the status of native avian species and is responsible for establishing a list of state endangered and threatened birds in the State of Texas. TPWD is also responsible for the management and protection of animals. Protected animals are designated endangered or threatened. A state-listed endangered species is any species of fish or wildlife whose prospects of survival or recruitment within the state are in jeopardy. A state-listed threatened species is a species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range in Texas. The State of Texas also lists rare species which (hereafter referred to as species of concern) are not protected by state laws or regulations.

4.0 LISTED SPECIES FOR THE PROJECT ALTERNATIVES

4.1 Federal Species

The proposed project is located in Bexar County, Texas. A large number of karst species are federally listed for the county. Karst habitat primarily occurs north and northwest of San Antonio is not known to occur in the project area (USAF 2007); therefore, listed karst species are not assessed in this report.

The USFWS lists three endangered bird species, two endangered (extirpated) mammal species, and one candidate bird species for the county (**Table 4-1**). Critical habitat is not designated in the project area for any of the potentially occurring federally listed species.

4.2 State Species

The State of Texas lists four endangered bird species and two endangered (extirpated) mammal species and two amphibians, four reptiles, five birds, and one mammal species as threatened. TPWD lists seven plant, one amphibian, two reptile, four bird, and three mammal species as species of concern (**Table 4-1**).

4.3 Migratory Birds

The proposed project is located in USFWS BCR 36 (Tamaulipan Brushlands). BCR 36 contains 36 MBTA species (**Table 4-2**).

Table 4-1
Federal- and state-listed threatened, endangered, candidate, and species of concern species of Bexar County[1]

Common Name	Scientific Name	Federal Status	State Status
Plants			
Big red sage	*Salvia pentstemonoides*	NL	SOC
Bracted twistflower	*Streptanthus bracteatus*	NL	SOC
Correll's false dragon-head	*Physostegia correllii*	NL	SOC
Elmendorf's onion	*Allium elmendorfii*	NL	SOC
Hill Country wild-mercury	*Argythamnia aphoroides*	NL	SOC
Parks' jointweed	*Polygonella parksii*	NL	SOC
Sandhill woollywhite	*Hymenopappus carrizoanus*	NL	SOC
Amphibians			
Cascade Caverns salamander	*Eurycea latitans complex*	NL	T
Comal blind salamander	*Eurycea tridentifera*	NL	T
Texas salamander	*Eurycea neotene*	LE	SOC
Reptiles			
Spot-tailed earless lizard	*Holbrookia lacera*	NL	SOC
Texas garter snake	*Thamnophis sirtalis annecten*	NL	SOC
Texas horned lizard	*Phrynosoma cornutum*	NL	T

Table 4-1 (*continued*)
Federal- and state-listed threatened, endangered, candidate, and species of concern species of Bexar County[1]

Common Name	Scientific Name	Federal Status	State Status
Reptiles			
Texas indigo snake	*Drymarchon melanurus erebennus*	NL	T
Texas tortoise	*Gopherus berlandieri*	NL	T
Canebrake rattlesnake	*Crotalus horridus*	NL	T
Birds			
American Peregrine Falcon	*Falco peregrinus anatum*	DL	T
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	DL	SOC
Black-capped Vireo	*Vireo atricapilla*	LE	E
Golden-cheeked Warbler	*Dendroica chrysoparia*	LE	E
Interior Least Tern	*Sterna antillarum athalassos*	NL	E
Mountain Plover	*Charadrius montanus*	NL	SOC
Peregrine Falcon	*Falco peregrinus*	DL	T
Sprague's Pipit	*Anthus spragueii*	C	SOC
Western Burrowing Owl	*Athene cunicularia hypugaea*	NL	SOC
White-faced Ibis	*Plegadis chihi*	NL	T
Whooping Crane	*Grus americana*	LE	E
Wood Stork	*Mycteria americana*	NL	T
Zone-tailed Hawk	*Buteo albonotatus*	NL	T
Mammals			
Black bear	*Ursus americanus*	T/SA;NL	T
Cave myotis bat	*Myotis velifer*	NL	SOC
Ghost-faced bat	*Mormoops megalophylla*	NL	SOC
Gray wolf	*Canis lupus*	NL	E[2]
Plains spotted skunk	*Spilogale putorius interrupta*	NL	SOC
Red wolf	*Canis rufus*	NL	E[2]

[1] Listed karst/cave species were not listed as karst formations are not present in the area.
[2] Extirpated
Source: TPWD 2011. USFWS 2011

C = Candidate
E = Endangered
DL = Delisted
LE =Listed Endangered
NL = Not Listed
PT = Proposed Threatened
T = Threatened
SA = Similarity of Appearance
SOC = Species of Concern

Table 4-2
Avian species found in Birds of Conservation Concern Region 36 (Tamaulipan Brushlands U.S. portion only)

Common Name	Scientific Name
Harris' Hawk	*Parabuteo unicinctus*
Swainson's Hawk	*Buteo swainsoni*
Snowy Plover (c)	*Charadrius alexandrinus*
Mountain Plover (nb)	*Charadrius montanus*
Solitary Sandpiper (nb)	*Tringa solitaria*
Lesser Yellowlegs (nb)	*Tringa flavipes*
Long-billed Curlew (nb)	*Numenius americanus*
Gull-billed Tern	*Gelochelidon nilotica*
Red-billed Pigeon	*Patagioenas flavirostris*
Green Parakeet (d)	*Aratinga holochlora*

Table 4-2 (*continued*)
Avian species found in Birds of Conservation Concern Region 36
(Tamaulipan Brushlands U.S. portion only)

Common Name	Scientific Name
Red-crowned Parrot (d)	*Amazona viridigenalis*
Elf Owl	*Micrathene whitneyi*
Burrowing Owl	*Athene cunicularia*
Buff-bellied Hummingbird	*Amazillia yucatanensis*
Northern Beardless-Tyrannulet	*Camptostoma imberbe*
Rose-throated Becard	*Pachyramphus aglaiae*
Bell's Vireo (c)	*Vireo bellii*
Verdin	*Auriparus flaviceps*
Curve-billed Thrasher	*Toxostoma curvirostre*
Sprague's Pipit (nb)	*Anthus spragueli*
Tropical Parula	*Parula pitiayumi*
Summer Tanager	*Piranga rubra*
White-collared Seedeater	*Sporophila torqueola*
Cassin's Sparrow	*Peucaea cassinii*
Lark Bunting (nb)	*Calamosiza melanocorys*
Chestnut-collared Longspur (nb)	*Calarius ornatrus*
Varied Bunting	*Passerina versicolor*
Painted Bunting	*Passerina ciris*
Dickcissel	*Spiza Americana*
Hooded Oriole	*Icterus cucullatus*
Altamira Oriole	*Icterus gularis*
Audubon's Oriole	*Icterus gradurcauda*

Source: USFWS 2008
Scientific nomenclature follows AOU (2007)
(c) non-listed subspecies or population of threatened or endangered species; (d) MBTA protection uncertain or lacking; (nb) non-breeding in this BCR

5.0 BIOLOGICAL ASSESSMENT/EVALUATION METHODS

5.1 Habitat Requirements Literature Research

Habitat preference requirements for current threatened, endangered, candidate species, as well as species of concern was obtained from TPWD (2011) and USFWS (2011) databases. Aerial photos, topographic maps, and soil surveys were analyzed to delineate general habitat types of the area which were compared to the TPWD and USFWS habitat requirement data to determine which species has the potential to occur in the project corridor.

5.2 Field Surveys

Habitat ground truthing and presence/absence surveys for listed species were conducted on 5-10 May 2011 by walking a 100-ft belt transect (50 ft on each side of the road centerline) and documenting habitat types encountered, any species observed, and evidence of species use (i.e., scat).

6.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

6.1 General Setting

Bexar County is located in a physiographic transition zone of the Balcones Canyon Lands, which includes portions of three physiographic regions: the Edwards Plateau, the Blackland

Prairie, and the Rio Grande Plain (also known as the South Texas Coastal Plain). The Edwards Plateau is north and west; the Blackland Prairie is east and southeast; and the Rio Grande Plain is south and southwest of Bexar County. This subregion is comprised of a landscape dissected by numerous high gradient streams in steep-sided canyons that flow south and southeast to the Gulf of Mexico (Riskind and Diamond 1988:1).

The location of Bexar County on the edge of the Gulf Coastal Plains, South Texas Plains, and Edwards Plateau results in a modified subtropical climate, predominantly continental in winter and marine in summer. The temperature ranges from an average monthly high of 95 degrees Fahrenheit (°F) in August and an average monthly low of 39°F in January (National Weather Service [NWS] 2011). Northerly winds prevail during most of the winter; however, southeasterly winds from the Gulf of Mexico prevail sometimes for long periods during the winter and during most the summertime. Average annual rainfall is 28 inches and is fairly well distributed throughout the year. From April through September, rain generally falls during thunderstorms, and fairly large amounts fall in a short time. In winter, most of the precipitation is in the form of light rains or drizzle, but thunderstorms and heavy rains may occur in any month (Taylor et al. 1962, NWS 2010). Relative humidity ranges from approximately 80 percent during the early hours of the day to approximately 50 percent during the afternoon (Taylor et al. 1962).

6.2 Vegetation Communities

The field survey resulted in the observation of five habitat types in the project areas; grassland/pasture, highly disturbed and naturalized, mesquite woodlands, riparian, and urban (**Figure 6-1**). These five habitats were distinguished and characterized by their associated vegetation communities (**Table 6-1**). Due to disturbance in the area, no high quality habitat was observed and invasive species were found in all habitat types.

Table 6-1
Habitat types and common flora of the project area

Habitat Type Observed	Associated Common Vegetation
Grassland/Pasture	Bermuda grass, silver bluestem, silverleaf nightshade, clover species, oldfield threeawn (*Aristida oligantha*), thistle sp.
Highly Disturbed And Naturalized	Cottonwood (*Populus* sp.), cedar elm (*Ulmus crassifolia*), Chinese tallow (*Triadica sebifera),* black willows (*Salix nigra*), boxelder (*Acer negundo),* sugarberry (*Celtis laevigata*), black walnut (*Juglans nigra*), pecan (*Carya illinoensis*), blackberry (*Rubus* sp.), green briar (*Smilax* sp.), poison ivy, giant ragweed, grape (*Vitis* spp.), and honeysuckle (*Lonicera* spp.).
Mesquite Woodlands	Honey mesquite (*Prosopis glandulosa*), sugarberry, silver bluestem (*Bothriochloa laguroides*) Texas prickly pear (*Opuntia engelmannii*), and silverleaf nightshade (*Solanum elaeagnifolium*).
Riparian	Cedar elm (*Ulmus crassifolia*), black “swamp” willow (*Salix nigra*), sugarberry (*Celtis laevigata*), chinaberry (*Melia azedarach*), pecan (*Carya illinoensis*), Canada wildrye (*Elymus candensis*), poison ivy (*Rhus radicans*), greenbrier (*Smilax* spp.), and giant ragweed (*Ambrosia trifida*).
Urban	Bermuda grass (*Cynodon dactylon*), Johnson grass (*Sorghum halepense*), crabgrass species (*Digitaria* sp.), dandelion species, henbit (*Lamium amplexicaule*), ornamental trees and shrubs.

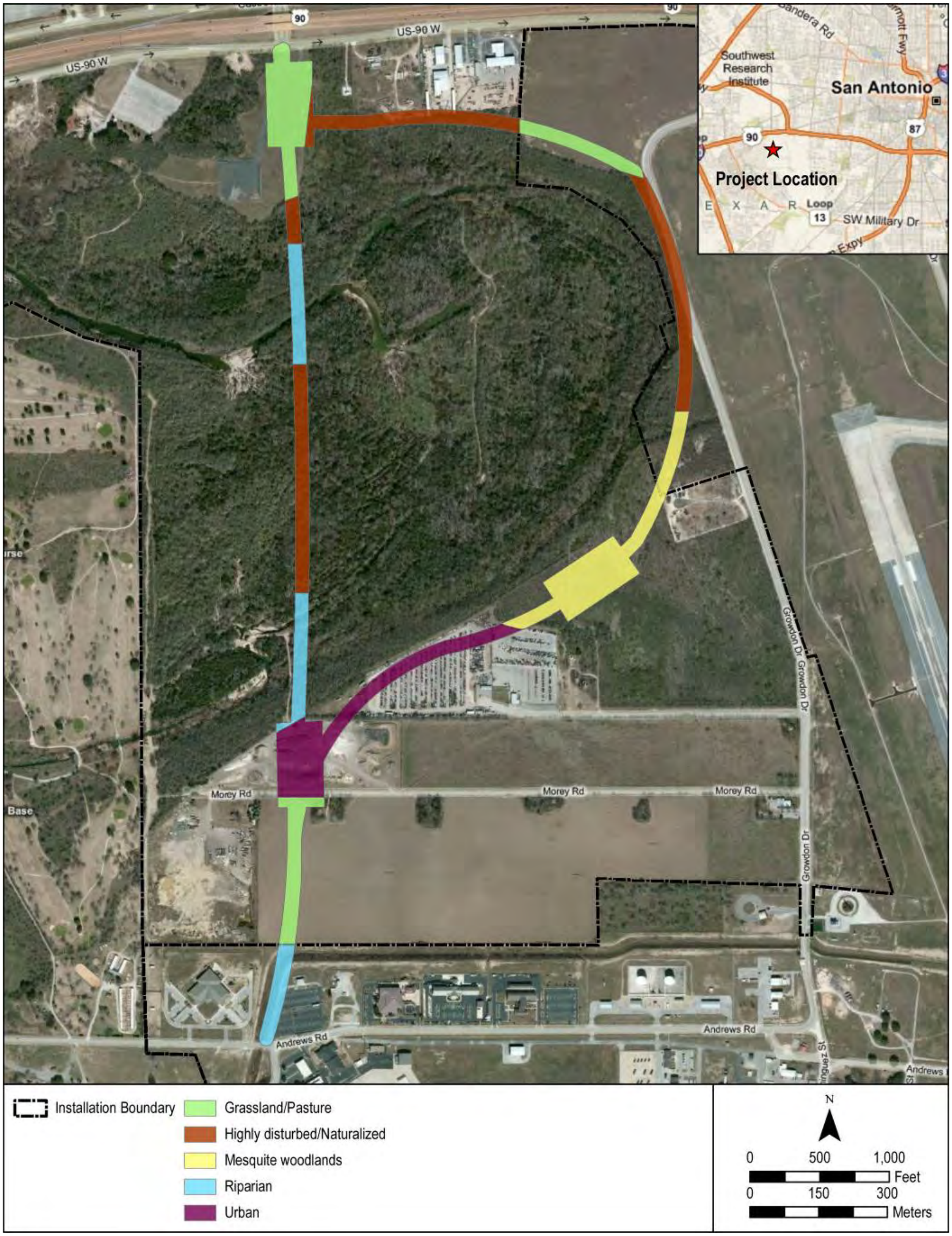

Figure 6-1. Map of vegetation communities.

6.3 Surface Water and Wetlands

Leon Creek crosses the project in project Alternatives 1 and 2 (**Figure 6-2**). The northern crossing is close to two large sandbars to the east and to the west that could potentially serve as nesting habitat for the federally endangered least tern. Many fish species are likely to occur in Leon Creek including bluegill (*Lepomis macrochirus*), long-eared sunfish (*Lepomis megalotis*), channel catfish (*Ictalurus punctatus*), and largemouth bass (*Micropterus salmoides*). Red-eared sliders (*Trachemys scripta elegans*) and spiny softshell turtles (*Apalone spinifera guadalupensis*) also inhabit these waters.

Most of the area associated with Alternatives 1 and 2 is traversing flood zone property, based on visual observations during field surveys and current flood plain maps. In addition, the area appears to have been a quarry; the remaining pitted areas have become naturalized wetlands. These wetland areas provide habitat for many frog and toad species including Rio Grande leopard frog (*Rana berlandieri*), Blanchard's cricket frog (*Acris crepitans blanchardi*), and gulf coast toad (*Bufo balliceps*).

Figure 6-2. Photo showing Leon Creek.

6.4 Wildlife Communities

Wildlife communities are described below within each vegetation community type. **Appendix A** contains a list of wildlife sighted during the 5-10 May 2011 surveys.

6.4.1 Grassland/Pasture Habitat

The grassland/pasture habitat contains a variety of grasses and forbs and provides good foraging areas for western kingbird (*Tyrannus verticalis*), scissor-tailed flycatcher (*Tyrannus forficatus*), and barn swallow (*Hirundo rustica*). A photograph showing Grassland/Pasture habitat can be seen in **Figure 6-3**.

Figure 6-3. Photo showing grassland/pasture habitat.

6.4.2 Highly Disturbed and Naturalized Habitat

The highly disturbed and naturalized habitat contains a mixture of mature native and introduced trees, grasses, and other vegetation. This habitat includes old quarries, landfills, and road improvement areas that have been allowed to naturalize (**Figure 6-4**). This habitat hosts many wildlife species including northern cardinal (*Cardinalis cardinalis*), black-crested titmouse (*Baeolophus bicolor*), golden-fronted woodpecker (*Melanerpes aurifrons*), white-tailed deer (*Odocoileus virginianus*), eastern fox squirrel (*Sciurus niger*), and common raccoon (*Procyon lotor*). The tall cottonwoods provide excellent perches and potential nesting habitat for barred owl (*Strix varia*), red-tailed hawk (*Buteo jamaicensis*) and red-shouldered hawk (*Buteo lineatus*).

Figure 6-4. Photo showing highly disturbed and naturalized habitat.

6.4.3 Mesquite Woodlands Habitat

The mesquite woodlands habitat is not a diverse plant community and consists mostly of mesquite trees/shrubs (**Figure 6-5**). Common wildlife occurring in this habitat type including mourning dove (*Zenaida macroura*), white-winged dove (*Zenaida asiatica*), northern mockingbird, northern cardinal, common raccoon, coyote (*Canis latrans*), eastern cottontail (*Sylvilagus audubonii*), white-tailed deer, and Texas spiny lizard (*Sceloporus olivaceus*).

Figure 6-5. Photo showing mesquite woodlands habitat.

6.4.4 Riparian Habitat

All riparian habitat located within the project corridors is associated with Leon Creek (**Figure 6-6**). A wide variety of wildlife utilize this habitat type including a variety of toad and frog species, mourning dove, white-winged dove, northern cardinal, northern mockingbird, Carolina chickadee (*Poecile carolinensis*), tufted titmouse (*Baeolophus bicolor*), common raccoon, Virginia opossum (*Didelphis virginiana*), nine-banded armadillo (*Dasypus novemcinctus*), coyote, white-tailed deer, and feral hog (*Sus scrofa*). This habitat could potentially be used as a migration stopover or foraging area for American and Arctic peregrine falcon (*Falco peregrinus anatum/tundrius*), a state threatened species. Neotropical migratory birds utilize riparian corridors/floodplains for foraging and resting during spring and fall migration and would be expected to be present in the project corridors. At nearby Kelly Air Force Base, a neotropical migratory bird survey was conducted along a narrow riparian forested area along Leon Creek. Of the 106 bird species detected, 59 of the bird were neotropical migratory birds. Swifts, swallows, and flycatchers were the most common neotropical birds. Warbler diversity was fairly high (14 species) but abundance was low (U.S. Army Corps of Engineers 1995).

Figure 6-6. Photo showing riparian habitat.

6.4.5 Urban Habitat

The urban habitat includes homesteads, roads, impound lots, and gravel and dirt piles. The mixture of native and ornamental plants on this habitat hosts bird species such as white-winged dove, mourning dove, great-tailed grackle (*Quiscalus mexicanus*), house sparrow (*Passer domesticus*) and northern mockingbird. This community is not likely to support many wildlife species. A representative photo of urban habitat can be viewed in **Figure 6-7**.

Figure 6-7. Photo showing Urban habitat.

7.0 HABITAT SUITABILITY FOR LISTED SPECIES

Habitat requirements of potentially occurring listed species are compared to habitats present in the two potential project corridors (Proposed Action Alternatives 1 and 2; see **Section 6**) to determine potential presence/absence of the listed species. Habitat suitability for federal species listed as threatened, endangered, or candidate species under the ESA and as bird species of conservation concern and for state-listed species is provided in this section.

7.1 Federal

7.1.1 Endangered Species Act

Four species are federally listed for Bexar County. Suitable habitat does not exist for two of the endangered species (i.e., black-capped vireo [*Vireo atricapilla*], golden-cheeked warbler [*Dendroica chrysoparia*]), and one candidate species (Sprague's pipit [*Anthus spragueii*]). Temporary migratory foraging habitat may be present for whooping crane (*Grus americana*) in the Proposed Action project corridor in years when water levels are low in Leon Creek (**Table 7-1**).

Table 7-1
Habitat suitability for potentially occurring federally listed species in the proposed action alternative project corridors

Bird Habitat Requirements (Status)	Habitat Suitability
Black-capped Vireo (E) Oak-juniper woodlands with distinctive patchy, two-layered aspect; shrub and tree layer with open, grassy spaces; requires foliage reaching to ground level for nesting cover; return to same territory, or one nearby, year after year; deciduous and broad-leaved shrubs and trees provide insects for feeding; species composition less important than presence of adequate broad-leaved shrubs, foliage to ground level, and required structure; nesting season March-late summer	Proposed Action Breeding: No Migration: No Alternative 1 and 2 Breeding: No Migration: No
Golden-cheeked Warbler (E) Juniper-oak woodlands; dependent on Ashe juniper (also known as cedar) for long fine bark strips, only available from mature trees, used in nest construction; nests are placed in various trees other than Ashe juniper; only a few mature junipers or nearby cedar brakes can provide the necessary nest material; forage for insects in broad-leaved trees and shrubs; nesting late March-early summer	Proposed Action Breeding: No Migration: No Alternative 1 and 2 Breeding: No Migration: No
Sprague's Pipit (C) only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.	Proposed Action Breeding: No Migration: No Alternative 1 and 2 Breeding: No Migration: No
Whooping Crane (E) potential migrant via plains throughout most of state to coast; winters in coastal marshes of Aransas, Calhoun, and Refugio counties	Proposed Action Breeding: No Migration: Yes Alternative 1 and 2 Breeding: No Migration: Yes

[1] Extirpated
Source: listed species habitat requirements from TPWD 2011
C = Candidate
E = Endangered
T = Threatened
SA = Similarity of Appearance
SOC = Species of Concern

7.1.2 Bald and Golden Eagle Protection Act

Bald eagles often utilize lake and riparian areas for foraging. In the South Texas brushlands province, the bald eagle is a scarce to occasional visitor during winter and is not known to breed in the area. Golden eagles are vagrants in the project area (Arvin 2007).

7.1.3 Birds of Conservation Concern

Based on a habitat analysis, only six of the 36 birds of conservation concern have the potential to utilize the habitats within the proposed project alternatives for breeding/nesting (**Tables 7-2** and **7-3**). One of the six species, rose-throated becard (*Pachyramphus aglaiae*) is currently known only as a vagrant to the Rio Grande valley during winter (Checklist of the Birds of Texas). Probable breeding records exist in the region surrounding San Antonio for Bell's vireo (*Vireo bellii),* curve-billed thrasher (*Toxostoma curvirostre,)* and dickcissal (*Spiza Americana*). Summer tanager (*Piranga rubra*) and hooded oriole (*Icterus cucullatus*) are not known to breed in the San Antonio area (Benson and Arnold 2001).

Although limited in size, potential habitat for 10 migratory and/or wintering birds of conservation concern occurs within the proposed project alternatives (i.e., Harris' hawk (*Parabuteo unicinctus*) [All Alternatives], solitary sandpiper (*Tringa solitaria*) [Proposed Action], lesser yellowlegs (*Tringa flavipes*) [Proposed Action], Bell's vireo [Alternatives 1 and 2], curve-billed thrasher [Proposed Action and Alternative 1 and 2], tropical parula (*Parula pitiayumi*) [Alternatives 1 and 2], summer tanager [Proposed Action], lark bunting (*Calamosiza melanocorys)* [Alternatives 1 and 2], dickcissal [All Alternatives], and hooded oriole [Proposed Action]). Tropical parula and hooded orioles would be considered vagrants in the San Antonio area.

Table 7-2
Avian species found in Birds of Conservation Concern Region 36
(Tamaulipan Brushlands U.S. portion only)

Common Name	Scientific Name
Harris' Hawk	*Parabuteo unicinctus*
Swainson's Hawk	*Buteo swainsoni*
Snowy Plover (c)	*Charadrius alexandrinus*
Mountain Plover (nb)	*Charadrius montanus*
Solitary Sandpiper (nb)	*Tringa solitaria*
Lesser Yellowlegs (nb)	*Tringa flavipes*
Long-billed Curlew (nb)	*Numenius americanus*
Gull-billed Tern	*Gelochelidon nilotica*
Red-billed Pigeon	*Patagioenas flavirostris*
Green Parakeet (d)	*Aratinga holochlora*
Red-crowned Parrot (d)	*Amazona viridigenalis*
Elf Owl	*Micrathene whitneyi*
Burrowing Owl	*Athene cunicularia*
Buff-bellied Hummingbird	*Amazillia yucatanensis*
Northern Beardless-Tyrannulet	*Camptostoma imberbe*
Rose-throated Becard	*Pachyramphus aglaiae*
Bell's Vireo (c)	*Vireo bellii*
Verdin	*Auriparus flaviceps*
Curve-billed Thrasher	*Toxostoma curvirostre*

Table 7-2 (*continued*)
Avian species found in Birds of Conservation Concern Region 36
(Tamaulipan Brushlands U.S. portion only)

Common Name	Scientific Name
Sprague's Pipit (nb)	*Anthus spragueli*
Tropical Parula	*Parula pitiayumi*
Summer Tanager	*Piranga rubra*
White-collared Seedeater	*Sporophila torqueola*
Cassin's Sparrow	*Peucaea cassinii*
Lark Bunting (nb)	*Calamosiza melanocorys*
Chestnut-collared Longspur (nb)	*Calarius ornatrus*
Varied Bunting	*Passerina versicolor*
Painted Bunting	*Passerina ciris*
Dickcissel	*Spiza Americana*
Hooded Oriole	*Icterus cucullatus*
Altamira Oriole	*Icterus gularis*
Audubon's Oriole	*Icterus gradurcauda*

Source: USFWS 2008
Scientific nomenclature follows AOU (2007)
(c) non-listed subspecies or population of threatened or endangered species; (d) MBTA protection uncertain or lacking; (nb) non-breeding in this BCR

Table 7-3
Habitat suitability of Birds of Conservation Concern Region 36 within the study area

Common Name	Habitat Requirements	Suitable Habitat Present/ Occurrence Time
Harris' Hawk	**Nesting**: savanna, semi-arid woodland, and semi-desert especially near water[1] **Migration and Winter**: Arid desert scrub of mesquite, palo verde, and large catci in the southwest, river woodlands, and brushy flatlands[2]	No Yes
Swainson's Hawk	**Nesting**: savanna, prairie, desert, open-pine woodland, cultivated lands with scattered trees[1] **Migration:**: prairies, plains, deserts, large mountain valleys, savannahs, open pine-oak woodlands, and cultivated lands with scattered trees[2]	No No
Snowy Plover (c)	**Nesting**: beaches and dry mud or salt flats, sand margins of rivers. Lakes , and ponds[1] **Migration**: dry sandy coastal beaches above wash of the tides, sand spits or bars separating the ocean from coastal wetlands, estuarine margins, alkali flats, dry lake beds, or the shores of salt ponds and alkali lakes[2]	No No
Mountain Plover (nb)	**Nesting**: short-grass prairie on flat and gently sloping topography with sparse vegetation cover (>30% bare ground and very short grass [<2 inches])[2] **Migration and Winter**: alkali flats, plowed or burned fields, fallow fields, sod farms, bare dirt agricultural land, heavily grazed grassland[2]	No No

Table 7-3 (*continued*)
Habitat suitability of Birds of Conservation Concern Region 36 within the study area

Common Name	Habitat Requirements	Suitable Habitat Present/ Occurrence Time
Solitary Sandpiper (nb)	**Nesting**: taiga and inland muskeg with scattered mature trees or clumps of trees near freshwater lakes and ponds in the coniferous forest belt of boreal and subarctic regions[2] **Migration**: inland along shallow freshwater woodland streams, ponds, bogs, flooded marshes, stagnant pools, mudflats, and barnyard pudddies[2]	No Yes
Lesser Yellowlegs (nb)	**Nesting:** Nearctic coniferous regions into the low Arctic; tundra, muskeg, woodland clearings, and burned areas[1] **Migration**:; shallow prairie sloughs in open country, muddy shores of lakes and marshy ponds, sewage beds, river margins, and inland/coastal marshes[2]	No Yes
Long-billed Curlew (nb)	**Nesting**: prairies, grassy meadows, usually near water[1] **Migration**: grasslands ranging from moist meadowland to very dry prairie; frequents shallow margins of inland/coastal waters, open areas of marshes, Intertidal zones, or on sandbars[2]	No Yes
Gull-billed Tern	**Nesting**: sandy barrier islands, beaches, sandy shores of saline lagoons and marshes, and artificially-produced dredge spoil islands[3] **Migration:**: salt marshes, estuaries, lagoons and plowed fields, around lakes, and in freshwater marshes[4]	No No
Red-billed Pigeon	**Nesting:** semiarid woodlands near water[1] **Migration and Winter**: river thickets containing tall timber and thick undergrowth of thorny shrubs[2]	No No
Green Parakeet (d)	**Nesting**: tree cavities, old woodpecker holes, and rock crevices[5] **Migration and Wintering**: tropical lowland evergreen, deciduous, secondary, pine, and pine-oak forests[4]	No No
Red-crowned Parrot (d)	**Nesting**: tree cavities with no lining or other material added[6] **Migration and Wintering**: tropical lowland evergreen, gallery, and pine-oak forests[4]	No No
Elf Owl	**Nesting**: desert with catci, oak and riparian woodland, especially sycamores[1] **Migration and Wintering**: arid, low elevation desert areas and dry, woody vegetation up to 7,000 feet in elevation[2]	No No
Burrowing Owl	**Nesting**: grassland, prairie, savanna, open areas near human habitation, especially golf courses[1] **Migration and Wintering**: non-forested plains, grasslands, deserts, and open areas with mammal burrow mounds[2]	No No
Buff-bellied Hummingbird	**Nesting:** open woodlands, clearings, and shrub areas[1] **Migration and Wintering**: semiarid lowlands and coastal scrub, dense thickets, flowering bushes, and	No No

	tangled vines along banks of streams and ponds[2]	

Table 7-3 (*continued*)
Habitat suitability of Birds of Conservation Concern Region 36 within the study area

Common Name	Habitat Requirements	Suitable Habitat Present/ Occurrence Time
Northern Beardless-Tyrannulet	**Nesting:** open riparian woodlands and river bottom thickets[1] (Rio Grande Valley) **Migration and Wintering**: mesquite woodlands, cottonwoods, willows, elms, and great luecaenas[2](Rio Grande Valley)	No No
Rose-throated Becard	**Nesting**: woodland, open forest, scrub, and mangroves[1] **Migration and Wintering**: mature groves of trees (sycamore, cottonwood, and willow) situated near flowing water[2]	Yes Yes
Bell's Vireo (c)	**Nesting**: dense riparian thickets, mesquite, scrub oak near water in semiarid areas, and hedgerows between fields[1] **Migration and Wintering**: thickets near streams and rivers or with second-growth scrub, forest edges, and brush patches[2]	Yes Yes
Verdin	**Nesting**: desert and arid brush (mesquite and creosote bush)[1] **Migration and Wintering**: brushy valleys, oak slopes, and other semiarid habitats[2]	No No
Curve-billed Thrasher	**Nesting**: shrubland, semi-desert (cholla cactus and mesquite) and desert suburbia[1] **Migration and Wintering**: deserts with extensive thickets of thorny scrubs at edge of woodlands and dense large cactus, in brushy riparian, and residential area[2]	Yes Yes
Sprague's Pipit (nb)	**Nesting**: shortgrass prairie[1] **Migration and Wintering**: extensive grassland areas dominated by grasses of medium height and large alkaline meadows and meadow zones of large alkali lakes[2]	No No
Tropical Parula	**Nesting**: subtropical forest with Spanish moss[1] **Migration and Wintering**: dense or open woodlands, undergrowth, brush, and trees along edges of rivers, low dry woodlands, and semiarid cultivated valleys with scattered trees[2]	No Yes
Summer Tanager	**Nesting**: deciduous forest, open and riparian woodlands, and lowland pine savanna[1] **Migration and Wintering**: dry, open woodlands of oaks, pines, and hickories and rich bottomland forests[2]	Yes Yes
White-collared Seedeater	**Migration and Wintering**: open, grassy places including pastures, roadsides, weedy fields, or marshlands covered with tall grasses in vicinity of low-growing shrubs[2] (Rio Grande Valley)	No
Cassin's Sparrow	**Nesting**: grassland, shortgrass prairie with scatter bushes, mesquite, cactus, or yucca[1] **Migration and Wintering**: open grassland/short-grass prairie, mesquite grassland, in or near mountainous areas on grassy slopes, and sandy prairies[2]	No No

Table 7-3 (*continued*)
Habitat suitability of Birds of Conservation Concern Region 36 within the study area

Common Name	Habitat Requirements	Suitable Habitat Present/ Occurrence Time
Lark Bunting (nb)	**Nesting**: northern grasslands, prairie, meadows, and sagebrush[1] **Migration**: mixed short-grass prairie and other areas of predominately low growth as well as areas of taller grasses with scattered shrubs and distributed grasslands[2]	No Yes
Chestnut-collared Longspur (nb)	**Nesting:** short-grass prairie[1] **Migration and Wintering**: on cultivated fields and along edged areas, fencerows, and roadways[2]	No No
Varied Bunting	**Nesting**: arid thorny brush and thickets, dry washes, and arid scrub[1] **Migration and Wintering**: mesquite or thorny shrubs, brushy pastures, dense vegetation with few cottonwoods, foothill canyons and hilly/rocky terrain[2]	No Yes
Painted Bunting	**Nesting**: scattered brush, , riparian thickets, and weedy and shrubby areas[1] **Migration and Wintering**: open country with brushy and weedy fields, hedges, roadside shrubs, gullies, thickets along streambanks, shelterbelts, and gardens[2]	No No
Dickcissel	**Nesting:** grasslands, meadows, savanna, and cultivated/abandoned fields[1] **Migration and Wintering**: grasslands with tall grasses, forbs, or shrubs, planted fields, and fallow croplands[2]	Yes Yes
Hooded Oriole	**Nesting:** riparian woodland, palm groves, mesquite, arid scrub, and deciduous woodland around human habitation[1] **Migration and Wintering**: palm trees, mesquite, dry shrubs, and some deciduous/riparian woodlands as well as ranches and towns[2]	Yes Yes
Altamira Oriole	**Nesting**: deciduous forest, arid scrub, open woodland, and semidesert[1] **Migration and Wintering**: open woodlands, trees along fields and streams, scattered groves in pastures, and hillsides[2] in Rio Grande Valley	No No
Audubon's Oriole	**Nesting**: scrub, mesquite, riparian thickets, open oak woodland, and pine-oak associations[1] in Rio Grande Valley **Migration and Wintering**: dense forests along stagnant water courses or old stream beds, occurring in mesquite, hackberry, ebony blackbeard, or huisance with thick undergrowth of shrubs or small trees, and thickets in forests openings[2]	No No

[1] Ehrlich et al. 1988
[2] DeGraaf et al. 1991
[3]Clapp et al. 1983
[4]AOU 1998
(c) non-listed subspecies or population of threatened or endangered species; (d) MBTA protection uncertain or lacking; (nb) non-breeding in this BCR

7.2 State

Thirty-four species are listed by the state for Bexar County (**Table 7-4**). Suitable habitat exists for 14 state-listed species for Proposed Action and eight for Project Alternatives 1 and 2. For Proposed Action, five threatened, two endangered, and seven species of concern potentially occur within the project corridor. For Alternatives 1 and 2, two threatened and six species of concern potentially occur within the project corridor (**Table 7-5**).

Table 7-4
Habitat suitability for potentially occurring state-listed species in the potential project corridors

Listed Plant Habitat Requirements	Habitat Suitability
Big Red Sage (SOC) Texas endemic; moist to seasonally wet, steep limestone outcrops on seeps within canyons or along creek banks; occasionally on clayey to silty soils of creek banks and terraces, in partial shade to full sun; basal leaves conspicuous for much of the year; flowering June-October	Proposed Action: Yes Alternative 1 and 2: No
Bracted Twistflower (SOC) Texas endemic; shallow, well-drained gravelly clays and clay loams over limestone in oak juniper woodlands and associated openings, on steep to moderate slopes and in canyon bottoms; several known soils include Tarrant, Brackett, or Speck over Edwards, Glen Rose, and Walnut geologic formations; populations fluctuate widely from year to year, depending on winter rainfall; flowering mid April-late May, fruit matures and foliage withers by early summer	Proposed Action: No Alternative 1 and 2: No
Correll's False Dragon-head (SOC) Wet, silty clay loams on streamsides, in creek beds, irrigation channels and roadside drainage ditches; or seepy, mucky, sometimes gravelly soils along riverbanks or small islands in the Rio Grande; or underlain by Austin Chalk limestone along gently flowing spring-fed creek in central Texas; flowering May-September	Proposed Action: Yes Alternative 1 and 2: No
Elmendorf's Onion (SOC) Texas endemic; grassland openings in oak woodlands on deep, loose, well-drained sands; in Coastal Bend, on Pleistocene barrier island ridges and Holocene Sand Sheet that support live oak woodlands; to the north it occurs in post oak-black hickory-live oak woodlands over Queen City and similar Eocene formations; one anomalous specimen found on Llano Uplift in wet pockets of granitic loam; flowering March-April, May	Proposed Action: No Alternative 1 and 2: No
Hill Country Wild-mercury (SOC) Texas endemic; mostly in bluestem-grama grasslands associated with plateau live oak woodlands on shallow to moderately deep clays and clay loams over limestone on rolling uplands, also in partial shade of oak-juniper woodlands in gravelly soils on rocky limestone slopes; flowering April-May with fruit persisting until midsummer	Proposed Action: No Alternative 1 and 2: No
Parks' Jointweed (SOC) Texas endemic; mostly found on deep, loose, whitish sand blowouts (unstable, deep, xeric, sandhill barrens) in Post Oak Savanna landscapes over the Carrizo and Sparta formations; also occurs in early successional grasslands, along right-of-ways, and on mechanically disturbed areas; flowering June-late October or September-November	Proposed Action: No Alternative 1 and 2: No

Table 7-4 (*continued*)
Habitat Suitability for Potentially Occurring State-Listed Species in the Potential Project Corridors

Listed Plant Habitat Requirements	Habitat Suitability
Sandhill Woollywhite (SOC) Texas endemic; disturbed or open areas in grasslands and post oak woodlands on deep sands derived from the Carrizo Sand and similar Eocene formations; flowering April-June	Proposed Action: No Alternative 1 and 2: No
Cascade Caverns Salamander (T) Endemic; subaquatic; springs and caves in Medina River, Guadalupe River, and Cibolo Creek watersheds within Edwards Aquifer area	Proposed Action: No Alternative 1 and 2: No
Listed Amphibian Habitat Requirements	**Habitat Suitability**
Comal Blind Salamander (T) endemic; semi-troglobitic; found in springs and waters of caves	Proposed Action: No Alternative 1 and 2: No
Texas Salamander (SOC) Endemic; troglobitic; springs, seeps, cave streams, and creek headwaters; often hides under rocks and leaves in water; restricted to Helotes and Leon Creek drainages	Proposed Action: No Alternative 1 and 2: No
Listed Reptile Habitat Requirements	**Habitat Suitability**
Spot-tailed Earless Lizard (SOC) Central and southern Texas and adjacent Mexico; moderately open prairie-brushland; fairly flat areas free of vegetation or other obstructions, including disturbed areas; eats small invertebrates; eggs laid underground	Proposed Action: No Alternative 1 and 2: No
Texas Garter Snake (SOC) Wet or moist microhabitats are conducive to the species occurrence, but is not necessarily restricted to them; hibernates underground or in or under surface cover; breeds March-August	Proposed Action: Yes Alternative 1 and 2: Yes
Texas Horned Lizard (T) Open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September	Proposed Action: No Alternative 1 and 2: No
Texas Indigo Snake (T) Texas south of the Guadalupe River and Balcones Escarpment; thornbush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter	Proposed Action: No Alternative 1 and 2: No
Texas Tortoise (T) Open brush with a grass understory is preferred; open grass and bare ground are avoided; when inactive occupies shallow depressions at base of bush or cactus, sometimes in underground burrows or under objects; longevity greater than 50 years; active March-November; breeds April-November	Proposed Action: No Alternative 1 and 2: No

Table 7-4 (*continued*)
Habitat Suitability for Potentially Occurring State-Listed Species in the Potential Project Corridors

Listed Reptile Habitat Requirements	Habitat Suitability
Timber/Canebrake Rattlesnake (T) Swamps, floodplains, upland pine and deciduous woodlands, riparian zones, abandoned farmland; limestone bluffs, sandy soil or black clay; prefers dense ground cover, i.e. grapevines or palmetto	Proposed Action: Yes Alternative 1 and 2: No
Listed Bird Habitat Requirements	**Habitat Suitability**
American Peregrine Falcon (T) Year-round resident and local breeder in west Texas, nests in tall cliff eyries; also, migrant across state from more northern breeding areas in U.S. and Canada, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.	Proposed Action Breeding: No Migration: Yes Alternative 1 and 2 Breeding: No Migration: Yes
Arctic Peregrine Falcon (SOC) Migrant throughout state from subspecies' far northern breeding range, winters along coast and farther south; occupies wide range of habitats during migration, including urban, concentrations along coast and barrier islands; low-altitude migrant, stopovers at leading landscape edges such as lake shores, coastlines, and barrier islands.	Proposed Action Breeding: No Migration: Yes Alternative 1 and 2 Breeding: No Migration: Yes
Black-capped Vireo (E) Oak-juniper woodlands with distinctive patchy, two-layered aspect; shrub and tree layer with open, grassy spaces; requires foliage reaching to ground level for nesting cover; return to same territory, or one nearby, year after year; deciduous and broad-leaved shrubs and trees provide insects for feeding; species composition less important than presence of adequate broad-leaved shrubs, foliage to ground level, and required structure; nesting season March-late summer	Proposed Action Breeding: No Migration: No Alternative 1 and 2 Breeding: No Migration: No
Golden-cheeked Warbler (E) Juniper-oak woodlands; dependent on Ashe juniper (also known as cedar) for long fine bark strips, only available from mature trees, used in nest construction; nests are placed in various trees other than Ashe juniper; only a few mature junipers or nearby cedar brakes can provide the necessary nest material; forage for insects in broad-leaved trees and shrubs; nesting late March-early summer	Proposed Action Breeding: No Migration: No Alternative 1 and 2 Breeding: No Migration: No
Interior Least Tern (E) Subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony	Proposed Action: Breeding: Yes Migration: Yes Alternative 1 and 2 Breeding: No Migration: No
Mountain Plover (SOC) Breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous	Proposed Action Breeding: No Migration: No Alternative 1 and 2 Breeding: No Migration: Yes

Table 7-4 (*continued*)
Habitat Suitability for Potentially Occurring State-Listed Species in the Potential Project Corridors

Listed Bird Habitat Requirements	Habitat Suitability
Sprague's Pipit (SOC) Only in Texas during migration and winter, mid September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges.	Proposed Action Breeding: No Migration: No Alternative 1 and 2 Breeding: No Migration: No
Burrowing Owl (SOC) Open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows	Proposed Action Breeding: No Migration: No Alternative 1 and 2 Breeding: No Migration: No
White-faced Ibis (T) Prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats	Proposed Action Breeding: No Migration: Yes Alternative 1 and 2 Breeding: No Migration: No
Whooping Crane (E) Potential migrant via plains throughout most of state to coast; winters in coastal marshes of Aransas, Calhoun, and Refugio counties. Primarily utilizes aquatic edge habitats (ponds, lake	Proposed Action Breeding: No Migration: Yes Alternative 1 and 2 Breeding: No Migration: No
Wood Stork (T) Forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960	Proposed Action Breeding: No Migration: Yes Alternative 1 and 2 Breeding: No Migration: No
Zone-tailed Hawk (T) Arid open country, including open deciduous or pine-oak woodland, mesa or mountain county, often near watercourses, and wooded canyons and tree-lined rivers along middle-slopes of desert mountains; nests in various habitats and sites, ranging from small trees in lower desert, giant cottonwoods in riparian areas, to mature conifers in high mountain regions	Proposed Action Breeding: No Migration: Yes Alternative 1 and 2 Breeding: No Migration: Yes
Listed Mammal Habitat Requirements	**Habitat Suitability**
Black Bear (T/SA) Bottomland hardwoods and large tracts of inaccessible forested areas; due to field characteristics similar to Louisiana Black Bear (LT, T), treat all east Texas black bears as federal- and state-listed Threatened	Proposed Action: No Alternative 1 and 2: No

Table 7-4 (*continued*)
Habitat Suitability for Potentially Occurring State-Listed Species in the Potential Project Corridors

Listed Mammal Habitat Requirements	Habitat Suitability
Cave Myotis Bat (SOC) Colonial and cave-dwelling; also roosts in rock crevices, old buildings, carports, under bridges, and even in abandoned cliff swallow (*Hirundo pyrrhonota*) nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum cave of Panhandle during winter; opportunistic insectivore	Proposed Action Breeding: No Foraging: Yes Alternative 1 and 2 Breeding: No Foraging: Yes
Ghost-faced Bat (SOC) Colonially roosts in caves, crevices, abandoned mines, and buildings; insectivorous; breeds late winter-early spring; single offspring born per year colonially roosts in caves, crevices, abandoned mines, and buildings; insectivorous; breeds late winter-early spring; single offspring born per year	Proposed Action Breeding: No Foraging: Yes Alternative 1 and 2 Breeding: No Foraging: Yes
Gray Wolf (E[1]) Extirpated; formerly known throughout the western two-thirds of the state in forests, brushlands, or grasslands	Proposed Action: No Alternative 1 and 2: No
Plains Spotted Skunk (SOC) Catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie	Proposed Action: Yes Alternative 1 and 2: Yes
Red Wolf (E[1]) Extirpated; formerly known throughout eastern half of Texas in brushy and forested areas, as well as coastal prairies	Proposed Action: No Alternative 1 and 2: No

[1] Extirpated
Source: listed species habitat requirements from TPWD 2011
C = Candidate
E = Endangered
T = Threatened
SA = Similarity of Appearance
SOC = Species of Concern

Table 7-5
Summary of potentially suitable habitat for state-listed species

Common Name	Status	Proposed Action	Alternatives 1and 2
Big red sage	SOC	X	
Correll's false dragonhead	SOC	X	
Texas garter snake	SOC	X	X
Timber rattlesnake	T	X	
American Peregrine Falcon	T	X	X
Arctic Peregrine Falcon	SOC	X	X
Interior Least Tern	E	X	
Mountain Plover	SOC		X
White-faced Ibis	T	X	

Table 7-5 (*continued*)
Summary of potentially suitable habitat for state-listed species

Common Name	Status	Proposed Action	Alternatives 1and 2
Whooping Crane	E	X	
Wood Stork	T	X	
Zone-tailed Hawk	T	X	X
Cave myotis bat	SOC	X	X
Ghost-faced bat	SOC	X	X
Plains spotted skunk	SOC	X	X

E = Endangered
T = Threatened
SOC = Species of Concern

8.0 PROPOSED CONSERVATION MEASURES

The following conservation (mitigation) measures would be included in the proposed action.

- Road construction clearing activities would occur during the non-breeding season for birds (August through January) to ensure compliance with the MBTA.
- Standard road construction best management practices (e.g., silt fences, a storm water pollution prevention plan, and hazardous spill plan) would be implemented as necessary during project construction activities.

9.0 EFFECT DETERMINATION

9.1 Federal

9.1.1 Listed Species

Listed species effect determination for the proposed project is based on regulatory definitions developed by the USFWS. The three effect categories are: no effect; may affect, not likely to adversely affect; and may affect, likely to adversely affect.

- **No effect**- "A "no effect" determination means that there are absolutely no effects from the proposed action, positive or negative, to listed species. A no effect determination does not include effects that are insignificant (small in size), discountable (extremely unlikely to occur), or beneficial".

- **May affect, not likely to adversely affect**-"A "may affect", but not likely to adversely affect determination, can be reached for a proposed action where all effects are beneficial, insignificant, or discountable. Beneficial effects have contemporaneous positive effects without any adverse effects to the species or habitat (there cannot be a balancing, where the benefits of the proposed action would be expected to outweigh the adverse effects). Insignificant effects relate to the size of the effects and should not reach the scale where take occurs. Discountable effects are those that are extremely unlikely to occur".

- **May affect, likely to adversely affect**- "A **"**may affect", likely to adversely affect determination means that all adverse effects cannot be avoided. A combination of beneficial and adverse effects is still "likely to adversely affect" even if the net effect is neutral or positive".

For both of the Proposed Action and project alternatives, no effect would occur to black-capped vireo, golden-cheeked warbler, and Sprague's pipit populations because suitable breeding habitat is not present for these species. Although unlikely, whooping crane could occur as a migrant if suitable foraging conditions exist in the riparian wetlands along and in Leon Creek. Whooping crane is not likely to be adversely affected if either the Proposed Action or project alternative are selected because of the small size of the project (**Table 9-1**).

9.1.2 Bald and Golden Eagle

Based on occurrence data compiled for the South Texas Brushlands province (Arvin 2007), bald eagle and golden eagle are not known to nest in the region and are only occasional (rare) in the region. Bald eagle or golden eagle is unlikely to occur in the project area. If either species would occur; it is not likely that either species would be adversely affected by selection of either the Proposed Action or the potential project alternatives.

Table 9-1
Relocation of the Growdon Gate Project effect determination for federally listed species of Bexar County

Common Name	Status	Scientific Name	Project Effect
Birds			
Black-capped Vireo	E	*Vireo atricapilla*	No effect[1]
Golden-cheeked Warbler	E	*Dendroica chrysoparia*	No effect[1]
Sprague's Pipit	C	*Anthus spragueii*	No Effect[1]
Whooping Crane	E	*Grus americana*	Not likely to adversely affect

[1] No suitable habitat for the species in the Proposed Action, Alternative 1 and Alternative 2 road project corridors
Source for listed species status: USFWS 2011
C = Candidate
LE =Listed Endangered

9.1.3 Migratory Birds

The riparian wetland habitat provides breeding sites for several birds, listed by the MBTA, within the road corridor proposed under Project Alternative 1 and Alternative 2. To mitigate the potential loss of migratory bird nests during construction, it is recommended that construction clearing activities be scheduled for the non-breeding months (August through January). Proposed Action is located primarily outside of the riparian habitat along Leon Creek and would have a negligible effect on breeding MBTA species. The riparian wetland habitat along Leon Creek also has the potential to provide foraging and resting habitat for migratory birds. A small amount of this suitable foraging habitat would be lost and fragmented by the Alternative 1 and Alternative 2 routes through riparian wetlands. In addition, all standard construction best management practices would be used to protect adjacent habitat from degradation and contamination. Overall, with the recommended mitigation, the project alternatives should not adversely affect the population of any occurring migratory bird species.

9.1.4 Birds of Conservation Concern

Curve-billed thrasher was the only bird of conservation of concern present during the breeding season. Construction of either alternative would result in a minimal loss of suitable breeding habitat. As a result, habitat loss due to project construction to migratory birds of conservation of concern may affect but not adversely affect all of the potentially occurring birds of conservation concern.

9.2 State

Based on the habitat assessment, suitable habitat exists for 14 of the 36 state-listed threatened and endangered species and species of concern listed for Bexar County. No effect would occur to the 21 species within Proposed Action and for 28 species within Project Alternatives 1 and 2 because of the absence of suitable habitat (**Tables 9-2** and **9-3**).

9.2.1 Plants

All state-listed species of concern plants would not be affected by construction of the Proposed Action or proposed alternatives as the appropriate habitat to support these species does not exist within the project corridors.

9.2.2 Reptiles

If present, it is unlikely that a significant population of Texas garter snake (*Thamnophis sirtalis annecten)*, Texas indigo snake (*Drymarchon melanurus erebennus*) and timber rattlesnake (*Crotalus horridus horridus*) in the project area because of existing habitat fragmentation at and in the vicinity of the project area. Texas garter snake, Texas indigo snake, and timber rattlesnake are not likely to be adversely affected by the Proposed Action or alternative because of the small area permanently affected by implementation of the project.

9.2.3 Birds

American peregrine falcon, Arctic peregrine falcon, and zone-tailed hawk (*Buteo albonotatus*) are spring/fall migrants. Impacts to these species from construction activities could occur if construction was conducted during the spring months; however, if construction occurs during summer or winter months, impacts are not likely to occur. If construction takes place in the fall, it may result in an avoidance of the construction area and a minor loss of potential foraging habitat for all species. This minor impact would not be likely to significantly affect the populations of either falcon or the zone-tailed hawk.

Interior least terns require sand bars in creeks and rivers as nesting habitat. Suitable nesting habitat is located adjacent to the Alternative 1 and Alternative 2. In addition, old sand and gravel mining sites, which are also possible nesting sites, are present nearby in the Leon Creek floodplain property. Sand bars are present to the east and west of where the north bridge crossing would be built for Alternative 1 and Alternative 2; however, suitable foraging may or may not exist nearby. The waters of Leon Creek were observed to have forage fish, however, the water within and in the general vicinity was murky and as a result does not provide for optimum interior least tern foraging conditions. No interior least terns were observed. If Alternative 1 or Alternative 2 is selected, the described location should be re-surveyed to determine if interior least terns have colonized the site.

Table 9-2
Potential Project Proposed Action:
Effect Determination for State-Listed Species of Bexar County

Common Name	Status	Scientific Name	Project Effect
Plants			
Big red sage	SOC	*Salvia pentstemonoides*	Not likely to adversely affect
Bracted twistflower	SOC	*Streptanthus bracteatus*	No Effect[1]
Correll's false dragon-head	SOC	*Physostegia correllii*	Not likely to adversely affect
Elmendorf's onion	SOC	*Allium elmendorfii*	Not likely to adversely affect
Hill Country wild-mercury	SOC	*Argythamnia aphoroides*	No Effect[1]
Parks' jointweed	SOC	*Polygonella parksii*	No Effect[1]
Sandhill woollywhite	SOC	*Hymenopappus carrizoanus*	No Effect[1]
Amphibians			
Cascade Caverns salamander	T	*Eurycea latitans complex*	No Effect[1]
Comal blind salamander	T	*Eurycea tridentifera*	No Effect[1]
Texas salamander	SOC	*Eurycea neotene*	No Effect[1]
Reptiles			
Spot-tailed earless lizard	SOC	*Holbrookia lacera*	No Effect[1]
Texas garter snake	SOC	*Thamnophis sirtalis annecten*	Not likely to adversely affect
Texas horned lizard	T	*Phrynosoma cornutum*	No Effect[1]
Texas indigo snake	T	*Drymarchon melanurus erebennus*	No Effect[1]
Texas tortoise	T	*Gopherus berlandieri*	No Effect[1]
Canebrake rattlesnake	T	*Crotalus horridus*	Not likely to adversely affect
Birds			
American Peregrine Falcon	T	*Falco peregrinus anatum*	Not likely to adversely affect
Arctic Peregrine Falcon	SOC	*Falco peregrinus tundrius*	Not likely to adversely affect
Black-capped Vireo	E	*Vireo atricapilla*	No Effect[1]
Golden-cheeked Warbler	E	*Dendroica chrysoparia*	No Effect[1]
Interior Least Tern	E	*Sterna antillarum athalasso)*	Not likely to adversely affect
Mountain Plover	SOC	*Charadrius montanus*	Not likely to adversely affect
Sprague's Pipit	SOC	*Anthus spragueii*	No Effect[1]
Western Burrowing Owl	SOC	*Athene cunicularia hypugaea*	No Effect[1]
White-faced Ibis	T	*Plegadis chihi*	No Effect[1]
Whooping Crane	E	*Grus americana*	No Effect[1]
Wood Stork	T	*Mycteria americana*	Not likely to adversely affect
Zone-tailed Hawk	T	*Buteo albonotatus*	Not likely to adversely affect
Mammals			
Black bear	T	*Ursus americanus*	No Effect[1]
Cave myotis bat	SOC	*Myotis velifer*	Not likely to adversely affect
Ghost-faced bat	SOC	*Mormoops megalophylla*	Not likely to adversely affect
Gray wolf	E[1]	*Canis lupus*	No Effect[2]
Plains spotted skunk	SOC	*Spilogale putorius interrupta*	Not likely to adversely affect
Red wolf	E[1]	*Canis rufus*	No Effect[2]

[1] No suitable habitat for the species in the Proposed Action or the Alternative 1 or Alternative 2 road project corridors
[2] Extirpated
Source for listed species status: Texas Parks and Wildlife Department 2011; USFWS 2011
C = Candidate
DL = Delisted
LE =Listed Endangered
NL = Not Listed
T = Threatened
SA = Similarity of Appearance
SOC = Species of Concern

Table 9-3
Potential Project Alternatives 1 and 2:
Effect Determination for State-Listed Species of Bexar County

Common Name	Status	Scientific Name	Project Effect
Plants			
Big red sage	SOC	*Salvia pentstemonoides*	No Effect[1]
Bracted twistflower	SOC	*Streptanthus bracteatus*	No Effect[1]
Correll's false dragon-head	SOC	*Physostegia correllii*	No Effect[1]
Elmendorf's onion	SOC	*Allium elmendorfii*	No Effect[1]
Hill Country wild-mercury	SOC	*Argythamnia aphoroides*	No Effect[1]
Parks' jointweed	SOC	*Polygonella parksii*	No Effect[1]
Sandhill woollywhite	SOC	*Hymenopappus carrizoanus*	No Effect[1]
Amphibians			
Cascade Caverns salamander	T	*Eurycea latitans complex*	No Effect[1]
Comal blind salamander	T	*Eurycea tridentifera*	No Effect[1]
Texas salamander	SOC	*Eurycea neotene*	No Effect[1]
Reptiles			
Spot-tailed earless lizard	SOC	*Holbrookia lacera*	No Effect[1]
Texas garter snake	SOC	*Thamnophis sirtalis annecten*	Not likely to adversely affect
Texas horned lizard	T	*Phrynosoma cornutum*	No Effect[1]
Texas indigo snake	T	*Drymarchon melanurus erebennus*	Not likely to adversely affect
Texas tortoise	T	*Gopherus berlandieri*	No Effect[1]
Canebrake rattlesnake	T	*Crotalus horridus*	No Effect[1]
Birds			
American Peregrine Falcon	T	*Falco peregrinus anatum*	Not likely to adversely affect
Arctic Peregrine Falcon	SOC	*Falco peregrinus tundrius*	Not likely to adversely affect
Black-capped Vireo	E	*Vireo atricapilla*	No Effect[1]
Golden-cheeked Warbler	E	*Dendroica chrysoparia*	No Effect[1]
Interior Least Tern	E	*Sterna antillarum athalasso)*	No Effect[1]
Mountain Plover	SOC	*Charadrius montanus*	Not likely to adversely affect
Sprague's Pipit	SOC	*Anthus spragueii*	No Effect[1]
Western Burrowing Owl	SOC	*Athene cunicularia hypugaea*	No Effect[1]
White-faced Ibis	T	*Plegadis chihi*	No Effect[1]
Whooping Crane	E	*Grus americana*	No Effect[1]
Wood Stork	T	*Mycteria americana*	No Effect[1]
Zone-tailed Hawk	T	*Buteo albonotatus*	Not likely to adversely affect
Mammals			
Black bear	T	*Ursus americanus*	No Effect[1]
Cave myotis bat	SOC	*Myotis velifer*	Not likely to adversely affect
Ghost-faced bat	SOC	*Mormoops megalophylla*	Not likely to adversely affect
Gray wolf	E[1]	*Canis lupus*	No Effect[2]
Plains spotted skunk	SOC	*Spilogale putorius interrupta*	Not likely to adversely affect
Red wolf	E[1]	*Canis rufus*	No Effect[2]

[1] No suitable habitat for the species in the Proposed Action road project corridor
[2] Extirpated
Source for listed species status: Texas Parks and Wildlife Department 2011; USFWS 2011
C = Candidate
DL = Delisted
LE =Listed Endangered
NL = Not Listed
T = Threatened
SA = Similiarity of Appearance
SOC = Species of Concern

Whopping crane and wood stork (*Mycteria Americana*) may potentially use the riparian habitat along Leon Creek during migration and post-nuptial wanderings respectively if water levels are suitable for foraging. Occurrence of the whooping crane would be accidental because no observation records have been documented for the South Texas Brushlands (Arvin 2007). Wood stork are listed as a common species in the region. The loss of a small area of potential foraging habitat in the Leo Creek floodplain would be a minor impact to wood stork. If present, whopping crane and wood stork are not likely to be adversely affected by the selection of Alternative 1 or Alternative 2.

9.2.4 Mammals

Three mammals, cave myotis bat (*Myotis velifer*), ghost-faced bat (*Mormoops megalophylla*), and plains spotted skunk (*Spilogale putorius interrupta*) are not know to occur within the project corridors but have the potential to occur and forage in the project area. The loss of foraging habitat would be small if either alternative was selected and therefore the selected Proposed Action would not be likely to adversely these mammals.

10.0 SUMMARY

Based on the habitat suitability analysis, on-site surveys, occurrence data for the region and the conservation measures that would be implemented during construction, federal- and state-listed species potentially occurring in the selected project alternatives are not likely to be adversely affected by the Proposed Action or Alternative 1 or Alternative 2.

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APPENDIX A

Wildlife Observed During the Habitat Assessment and Survey

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Observed Fauna Species

Birds

Common Name	Scientific Name	Status[1]	Proposed Action	Alternative 1 & 2
Vultures				
Black Vulture	*Coragyps atratus*	R	X	X
Turkey Vulture	*Cathartes aura*	R	X	X
Hawks				
Red-shouldered Hawk	*Buteo lineatus*	R	X	
Red-tailed Hawk	*Buteo jamaicensis*	R	X	
Swainson's Hawk	*Buteo swainsoni*	NTMB	X	
Doves				
Rock Pigeon	*Columba livia*	R		X
Mourning Dove	*Zenaida macroura*	R	X	X
White-winged Dove	*Zenaida asiatica*	R	X	X
Cuckoo				
Yellow-billed Cuckoo	*Coccyzus americanus*	NTMB	X	
Owl				
Barred Owl	*Strix varia*	R	X	
Hummingbird				
Hummingbird	*Archilochus* spp.	R	X	
Woodpeckers				
Golden-fronted Woodpecker	*Melanerpes aurifrons*	R	X	X
Ladder-backed Woodpecker	*Picoides scalaris*	R	X	
Flycatchers				
Kingbird	*Tyrannus* spp.	NTMB	X	
Scissor-tailed Flycatcher	*Tyrannus forficatus*	NTMB	X	X
Vermillion Flycatcher	*Pyrocephalus rubinus*	R	X	
Western Kingbird	*Tyrannus verticalis*	NTMB	X	X
Vireos				
White-eyed Vireo	*Vireo griseus*	NTMB/R	X	X
Swallows				
Barn Swallow	*Hirundo rustica*	NTMB	X	X
Cave/Cliff Swallow	*Petrochelidon* spp	R/NTMB	X	
Chickadee				
Carolina Chickadee	*Poecile carolinensis*	R	X	X
Titmouse				
Black-crested Titmouse	*Baeolophus atricristatus*	R	X	
Wrens				
Bewick's Wren	*Thryomanes bewickii*	R	X	
Carolina Wren	*Thryothorus ludovicianus*	R	X	X

Common Name	Scientific Name	Status[1]	Proposed Action	Alternative 1 & 2
Gnatcatcher				
Blue-gray Gnatcatcher	*Polioptila caerulea*	R	X	
Mockingbirds				
Northern Mockingbird	*Mimus polyglottos*	R	X	X
Thrasher				
Curve-billed Thrasher	*Toxostoma curvirostre*	R	X	
Starling				
European Starling	*Sturnus vulgaris*	R	X	X
Redstart				
American Redstart	*Setophaga ruticilla*	NTMB	X	
Cardinal				
Northern Cardinal	*Cardinalis cardinalis*	R	X	X
Sparrow				
Lark Sparrow	*Chondestes grammacus*	R	X	X
Sparrow	*Spizella* spp	U	X	X
Blackbirds				
Brown-headed Cowbird	*Molothrus ater*	R	X	X
Great-tailed Grackle	*Quiscalus mexicanus*	R	X	X
Red-winged Blackbird	*Agelaius phoeniceus*	R	X	X

[1] Arvin 2007
NTMB = Neotropical Migratory Bird
R = resident
U = Unknown

Amphibians and Reptiles

Common Name	Scientific Name	Proposed Action	Alternative 1 & 2
Amphibians			
Frogs			
Rio Grande Leopard Frog	*Rana berlandieri*	X	
Toads			
Toad	*Bufo* spp	X	
Reptiles			
Skink			
Ground Skink	*Scincella lateralis*	X	X
Lizards			
Green Anole	*Anolis carolinensis*	X	
Texas Spiny Lizard	*Sceloporus olivaceus*	X	X
Turtles			
Red-eared Slider	*Trachemys scripta elegans*	X	

Mammals

Common Name	Scientific Name	Proposed Action	Alternative 1 & 2
Common Raccoon	*Procyon lotor*	X	X
Coyote	*Canis latrans*	X	X
Eastern Cottontail	*Sylvilagus floridanus*	X	X
Eastern Fox Squirrel	*Sciurus niger*	X	X
Feral Pig	*Sus scrofa*	X	
Nine-banded Armadillo	*Dasypus novemcinctus*	X	
Virginia Opossum	*Didelphis virginiana*	X	
White-tailed Deer	*Odocoileus virginianus*	X	X

Fish

Common Name	Scientific Name	Proposed Action	Alternative 1 & 2
Long-eared Sunfish	*Lepomis megalotis*	X	

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Appendix C

Waters of the United States Delineation – Growdon Road and Commercial Vehicle Inspection Center

Growdon Road and Commercial Vehicle Inspection Center
San Antonio, Texas
Waters of the United States Delineation

Prepared for:

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August 2011

Final

WATERS OF THE UNITED STATES DELINEATION FOR ROAD AND GATE CONSTRUCTION AT LACKLAND AIR FORCE BASE, TEXAS

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AUGUST 2011

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Summary of Impacts for the Proposed Action and Alternatives

LIST OF ACRONYMS AND ABBREVIATIONS

°F	Degree(s) Fahrenheit
ac	Acre(s)
asml	Above Mean Sea Level
CFR	Code of Federal Regulations
CIR	Color Infrared
CVIC	Commercial Vehicle Inspection Center
CWA	Clean Water Act
DEM	Digital Elevation Model
EO	Executive Order
FAC	Faculative
FACW	Faculative Wetlands
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
ft	Foot (Feet)
GIS	Geographic Information Systems
GMI	Geo-Marine, Inc.
GG	Growdon Gate
GPS	Global Positioning System
in	Inch(es)
LAFB	Lackland Air Force Base
mi	Mile(s)
N/A	Not Applicable
NC	Natural Color
NDMC	National Drought Mitigation Center
NHD	National Hydrography Dataset
NOAA	National Oceanic and Atmospheric Administration
NTCHS	National Technical Committee for Hydric Soils
NWI	National Wetland Inventory
NWS	National Weather Service
OBL	Obligate
OHWM	Ordinary High Water Mark
PDSI	Palmer Drought Severity Index

LIST OF ACRONYMS AND ABBREVIATIONS

P.L.	Public Law
SBAS	Satellite-based Augmentation System
spp.	Species
SWANCC	Solid Waste Agency of Northern Cook County
TCEQ	Texas Center for Environmental Quality
TNRIS	Texas Natural Resource Information System
TWDB	Texas Water Development Board
U.S.	United States
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
Weston	Weston Solutions, Inc.
yr	Year

1.0 INTRODUCTION

1.1 PROPOSED PROJECT

Weston Solutions, Inc. (Weston) contracted Geo-Marine, Inc. (GMI) to conduct a waters and wetlands of the United States (U.S.) delineation on 3.4 miles (mi) of linear corridor area encompassing 55.5 acres (ac). Lackland Air Force Base (LAFB) has proposed the area be used for the relocation of the current Growdon Gate (GG) and construction of a Commercial Vehicle Inspection Center (CVIC) and access road. For the purpose of this report, hereafter the project will be referred to as the GG/CVIC. The proposed project is part of an effort to design a more effective access route to LAFB and expedite associated traffic flow. The GG/CVIC project may be expanded in future years; however, the current proposed project will be constructed as a stand-alone operation.

1.2 PROPOSED ACTION AND ALTERNATIVES

GMI conducted a waters and wetlands of U.S. delineation within the proposed project corridors corresponding to the proposed action and two alternatives (**Figure 1**). For the purposes of the delineation, all three GG/CVIC potential routes were buffered by 100 feet (ft; 50 ft on each side of the centerline) along the entire proposed project corridor to accommodate future construction, equipment maneuvering, and construction staging.

The proposed action would be to acquire land, construct an access road around the east side of Leon Creek, and relocate the GG and the CVIC west of the existing GG and CVIC. The new access road would be approximately 2.04 mi long. Approximately 24.84 ac of land would be impacted during road construction. The new GG/CVIC would affect approximately 4.73 ac of land.

For Alternative 1, the access road would be built across Leon Creek and the CVIC gate would be located at the north end of the proposed road alignment. The road would be approximately 1.34 mi long. For this option, approximately 16.48 ac of land would be impacted during road construction. The new entry GG/CVIC would affect approximately 4.73 ac of land.

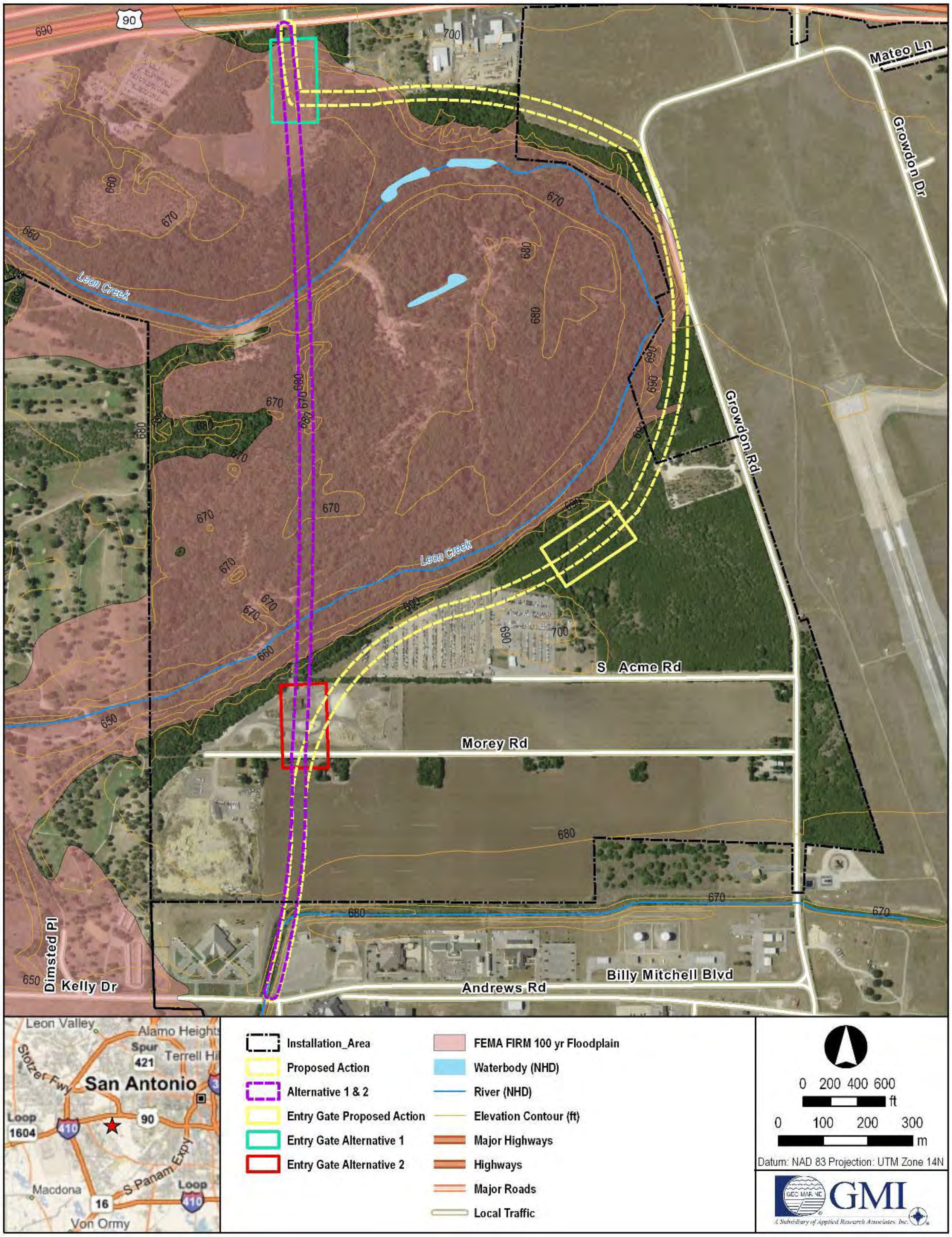


Figure 1. Location of Proposed and Alternative Actions within the Project Area.

Alternative 2 copies the road alignment of Alternative 1; however, the CVIC gate would be located at the south end of the proposed alternative road alignment. Approximately the same number of acres would be impacted as in Alternative 1.

1.3 PURPOSE AND NEED

Preliminary surveys indicated potential waters of the U.S. are found within the project corridor. To comply with Section 404 of the Clean Water Act (CWA), Ms. Christie Rivett conducted the on-site delineation, with the assistance of Mr. Chris Taylor and Mr. Casey Gomez, from 5 - 10 and 25 – 27 May 2011. The resulting effort identified nine potentially jurisdictional waters (totaling 0.5381 ac and 1,447.36 linear ft) and twelve potentially jurisdictional wetlands (totaling 0.5615 ac) within the GG/CVIC project corridors.

This report provides the location of all potentially jurisdictional wetlands and waters within the GG/CVIC proposed project corridors and evaluates the potential construction impacts to these resources. The results of this evaluation are presented as effects determinations, indicating if any such wetlands or waters of the U.S. are likely to be adversely affected by the proposed action or alternatives.

The primary objectives of this report are:

1. Provide an overview of the project;
2. Provide an overview of the definition of waters of the U.S. and Executive Order (EO) 11990 (*Protection of Wetlands*; **Appendix A**), as it pertains to this study;
3. Detail the methods and approach used to assess the project corridor and delineate wetlands and waters of the U.S. within the project corridor;
4. Provide an overview of literature reviews and field surveys;
5. Provide a detailed description, including representative photographs (**Appendix B**), of the wetlands and waters of the U.S. delineated during the field work; and
6. Provide an opinion regarding the potential presence of jurisdictional waters under Section 404 of the CWA and EO 11990.

2.0 REGULATORY BACKGROUND

2.1 SECTION 404 OF THE CLEAN WATER ACT

Section 404 of the CWA of 1977 (Public Law [P.L.] 95-217) authorizes the Secretary of the Army, acting through the U.S. Army Corps of Engineers (USACE), to issue permits for the discharge of dredged or fill material into waters of the U.S., including wetlands. Waters of the U.S. (Section 328.3[2] of the CWA) are those waters used in interstate or foreign commerce, subject to ebb and flow of tide, and all interstate waters including interstate wetlands (Environmental Laboratory 1987).

Jurisdictional waters of the U.S. are further defined as all other waters such as navigable waterways, intrastate lakes, rivers, streams, intermittent streams, mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, natural ponds or impoundments of waters, tributaries of waters, and territorial seas. The USACE Wetland Delineation Manual defines wetlands as areas that have positive indicators for hydrophytic vegetation, wetland hydrology, and hydric soils, as well as areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Wetlands within the 100-year (yr) floodplain of another water of the U.S. are considered to be "adjacent" and, therefore, jurisdictional. All other wetlands would be considered isolated and not jurisdictional under the CWA. Additionally, the USACE typically takes jurisdiction over wetlands only when they lie within or adjacent to navigable waters or tributaries of such waters where those tributaries bear an ordinary high water mark (OHWM).

The term "OHWM" is defined by the CWA (Section 328.3[e]) for the purposes of lateral jurisdiction, as the:

> *"…line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in soil character, destruction of terrestrial vegetation, presence of litter or debris, or other appropriate means that consider the characteristics of the surrounding areas."*

2.2 EXECUTIVE ORDER 11990

In accordance with EO 11990 (*Protection of Wetlands*, 24 May 1977), federal agencies performing activities located in or affecting wetlands, and or "providing federally undertaken, financed, or assisted construction", must ensure that their activities do not result in a net loss of wetlands. Compliance with the EO 11990 (**Appendix A**) necessitates knowledge of the types and locations of wetlands. To comply with the EO 11990, LAFB needs to have a current inventory of wetland resources in the proposed project area. Under the definition provided by the EO, wetland areas could be protected if the wetland supports a prevalence of vegetative life that requires saturated or seasonally saturated soil conditions for growth and reproduction.

Even if a wetland may not qualify as "jurisdictional" under the USACE's regulation definition, a wetland area could still be considered to be protected under EO 11990. The purpose of EO 11990 is to "minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands." To meet these objectives, the EO requires federal agencies, in planning their actions, to consider alternatives to federal actions impacting wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided.

3.0 METHODOLOGY

3.1 GEOGRAPHIC INFORMATION SYSTEM DATA ACQUISITION AND LITERATURE REVIEW

In preparation for field surveys, existing literature was reviewed to identify potential wetland or water areas and the extent of their boundaries. Although the literature does not provide sufficient details for a jurisdictional delineation, it provides background information to aid in the on-site survey, including areas of potential waters of the U.S. within the project corridor. The literature evaluated included: the Texas Natural Resource Information System (TNRIS) natural color (NC) and color infrared (CIR) aerial photography (TNRIS 2008-2009), the U.S. Geological Survey (USGS) 7.5-minute quadrangle map for Bexar, Texas (USGS 2009), the *Soil Survey of Bexar County, Texas* (Taylor et al. 1991), National Wetlands Inventory (NWI) maps (USFWS 2011), and the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM; FEMA 2007).

GMI's Geographic Information Systems (GIS) group assembled digital raster graphics, NWI, elevation, and soils data, and a National Hydrography Dataset (NHD) with the imagery and maps mentioned above to produce comprehensive maps of the project corridors. These maps were used to support identification and analysis of the geographic and hydrologic makeup of the project area, as well as to assist with the planning and execution of field surveys.

3.2 FIELD INVESTIGATION

The GG/CVIC proposed project corridors were assessed for waters and wetlands in accordance with the USACE Wetland Delineation Manual (Environmental Laboratory 1987). According to this manual, an area is identified as a wetland only if it meets all three wetlands parameters: hydric soils, hydrophytic vegetation, and wetlands hydrology. Field surveys consisted of identifying the vegetation, soils, and hydrology of potential wetland areas and marking the boundaries of the wetlands using pink streamer flags that were labeled "WETLAND DELINEATION" chronologically numbered in the field for accurate survey retrieval.

Within wetland areas, soil samples were taken using a shovel and compared to the Munsell Soil Color Chart (Munsell Color 1994) to determine if the soils were hydric. Vegetation was identified and the indicator status of each species was noted using the National List of Plant Species that Occur in Wetlands. Percent coverage of dominant vegetation with an indicator status of OBL (Obligate), FACW (Facultative Wetlands), and FAC (Facultative) was determined. For hydrology, indicators including water marks, drift lines, sediment deposits, water stained leaves, and oxidized root channels were identified, if present.

The boundaries of non-tidal, non-wetland waters (i.e., other waters of the U.S.) were delineated at the OHWM, as defined in 33 Code of Federal Regulations (CFR) 328.3. The OHWM represents the limit of USACE's jurisdiction over non-tidal waters (e.g., streams and ponds) in the absence of adjacent wetlands (33 CFR 328.4). The OHWM can be indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in soil character, destruction of terrestrial vegetation, presence of litter or debris, or other appropriate means that consider the characteristics of the surrounding areas.

The boundaries of wetlands and waters were flagged by GMI ecologists for future reference using pink streamer flags that were labeled “WETLAND DELINEATION.” The location of each of these flags was recorded with a Trimble GeoXT® global positioning system (GPS) system that uses EVEREST™ multipath rejection technology to provide submeter accuracy (Trimble 2010). To minimize error, data were collected as points (instead of lines or polygons). Each flag was marked by a permanent marker with a unique identifying number corresponding to each GPS point recorded by the ecologists.

GMI collected real-time data that enabled the ecologists to apply corrections while in the field and collect accurate GPS data by utilizing reference stations. Reference stations calculate and broadcast the error for each satellite as each measurement is received by the GPS unit. The reference sources included external beacon and radio sources, as well as a satellite-based augmentation system (SBAS) that uses multiple reference stations in a network to calculate the needed correction. To further minimize error, the GPS data points collected in the field were post-processed and differentially corrected with GPS Pathfinder® Office software. Post-processed data points were entered into a GIS program database, ArcGIS 10™, to create maps and compile geographic calculations.

4.0 RESULTS

4.1 DESKTOP ANALYSIS

4.1.1 Background Data

The GG/CVIC is located within the San Antonio city limits, in Bexar County, Texas, south of U.S. Highway 90 and north of Kelly Drive, located on LAFB (**Figure 1**). The 55.5 ac of the GG/CVIC project corridors are composed of properties owned by various stakeholders and the majority of the land proposed for development is currently undeveloped. The undeveloped land located in the floodplain area of Leon Creek (**Figure 1**), was once utilized for a gravel quarry operation. Remnant two-track roads and gravel pits are illustrated on the FEMA FIRM (**Figure 2**).

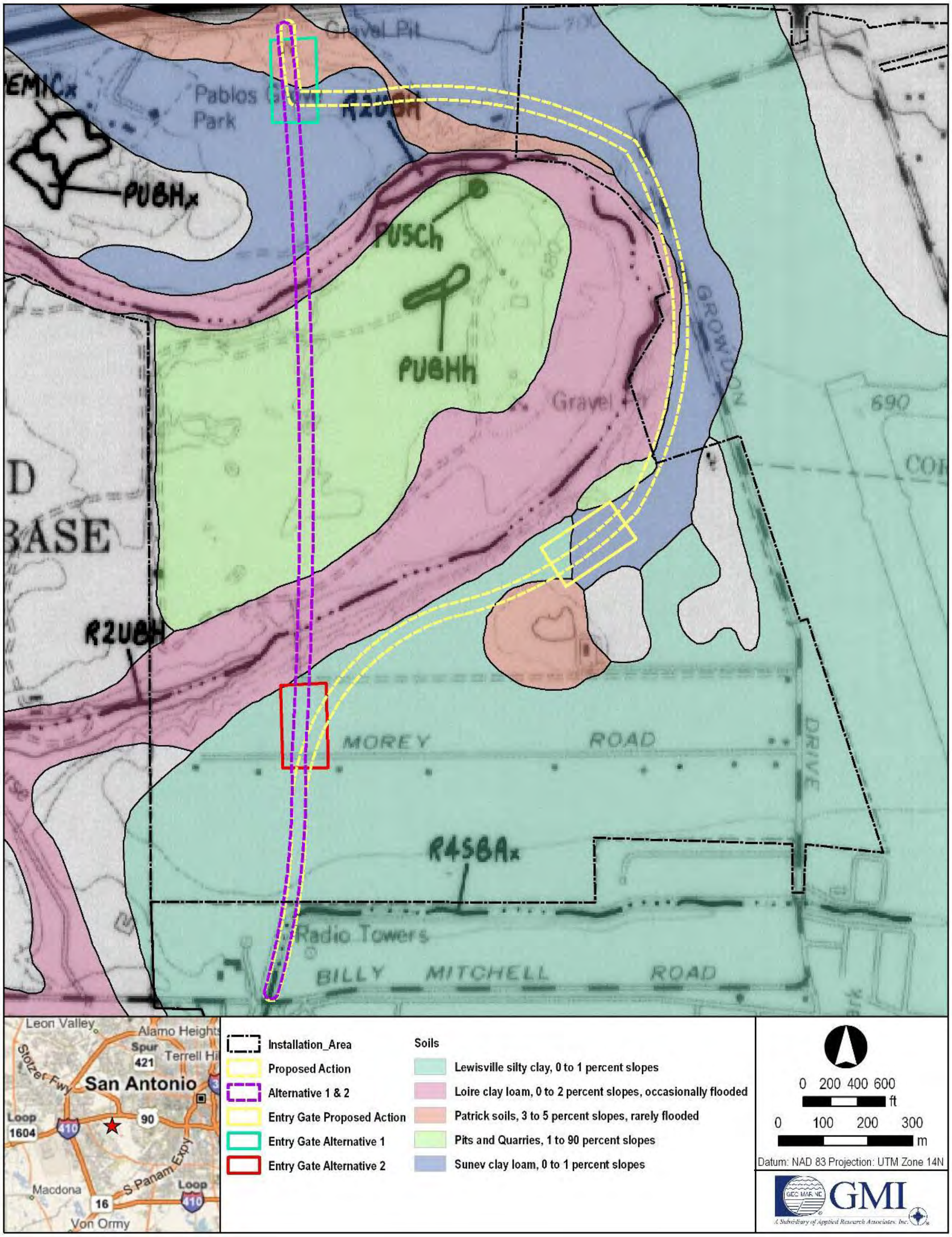


Figure 2. National Wetland Inventory and Soil Series.

4.1.2 General Physiography

Bexar County is located in a physiographic transition zone of the Balcones Canyonlands, which includes portions of three physiographic regions: the Edwards Plateau, the Blackland Prairie, and the Rio Grande Plain (also known as the South Texas Coastal Plain; Taylor et al. 1991). The Edwards Plateau is north and west; the Blackland Prairie is east and southeast; and the Rio Grande Plain is south and southwest of Bexar County. This subregion is comprised of a landscape dissected by numerous high-gradient streams in steep-sided canyons that flow south and southeast to the Gulf of Mexico (Riskind and Diamond 1988).

4.1.3 Climate

The location of Bexar County on the edge of the Gulf Coastal Plains, South Texas Plains, and Edwards Plateau results in a modified subtropical climate, predominantly continental in winter and marine in summer. The temperature ranges from an average monthly high of 95 degrees Fahrenheit (°F) in August and an average monthly low of 39°F in January (NWS 2011). Northerly winds prevail during most of the winter; however, southeasterly winds from the Gulf of Mexico prevail sometimes for long periods during the winter and during most the summertime.

Average annual rainfall is 28 inches (in) and is fairly well distributed throughout the year. From April through September, rain generally falls during thunderstorms and fairly large amounts fall in a short time. In winter, most of the precipitation is in the form of light rains or drizzle, but thunderstorms and heavy rains may occur in any month (Taylor et al. 1991, NWS 2011). Relative humidity ranges from approximately 80 percent during the early hours of the day to approximately 50 percent during the afternoon (Taylor et al. 1991).

4.1.4 Recent Weather

Severe dry/drought conditions have persisted from October 2010 to the present as a result of a persistent low precipitation pattern often referred to as a La Niña pattern. Drought is loosely defined as a “deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector” (NDMC 2011).

According to the Texas Water Development Board (TWDB), San Antonio is currently in "Extreme Drought" conditions. In addition, the National Oceanic and Atmospheric Administration (NOAA) Palmer Drought Severity Index (PDSI) indicates that PDSI values have increased in severity from May 2011 to June 2011 and is expected to maintain this trend into the near future (**Figure 3**). Seasonal alleviation of drought conditions is normally expected by the wet season summer rains but drought conditions are predicted to remain in place indefinitely (NWS 2011).

The National Drought Mitigation Center (NDMC) has categorized Bexar County as being in a "Stage 4" drought condition with "exceptional intensity" (**Figure 4**; NDMC 2011). Stage 4 drought conditions are in affect when there are exceptional and widespread crop/pasture losses and shortages of water in reservoirs, streams, and wells creating water emergencies.

Atypical weather for the region has resulted in an ongoing drought making this delineation difficult to conduct. The drought caused soils, which may normally be saturated, to be dry and vegetation that would normally be growing and/or in bloom to be dormant.

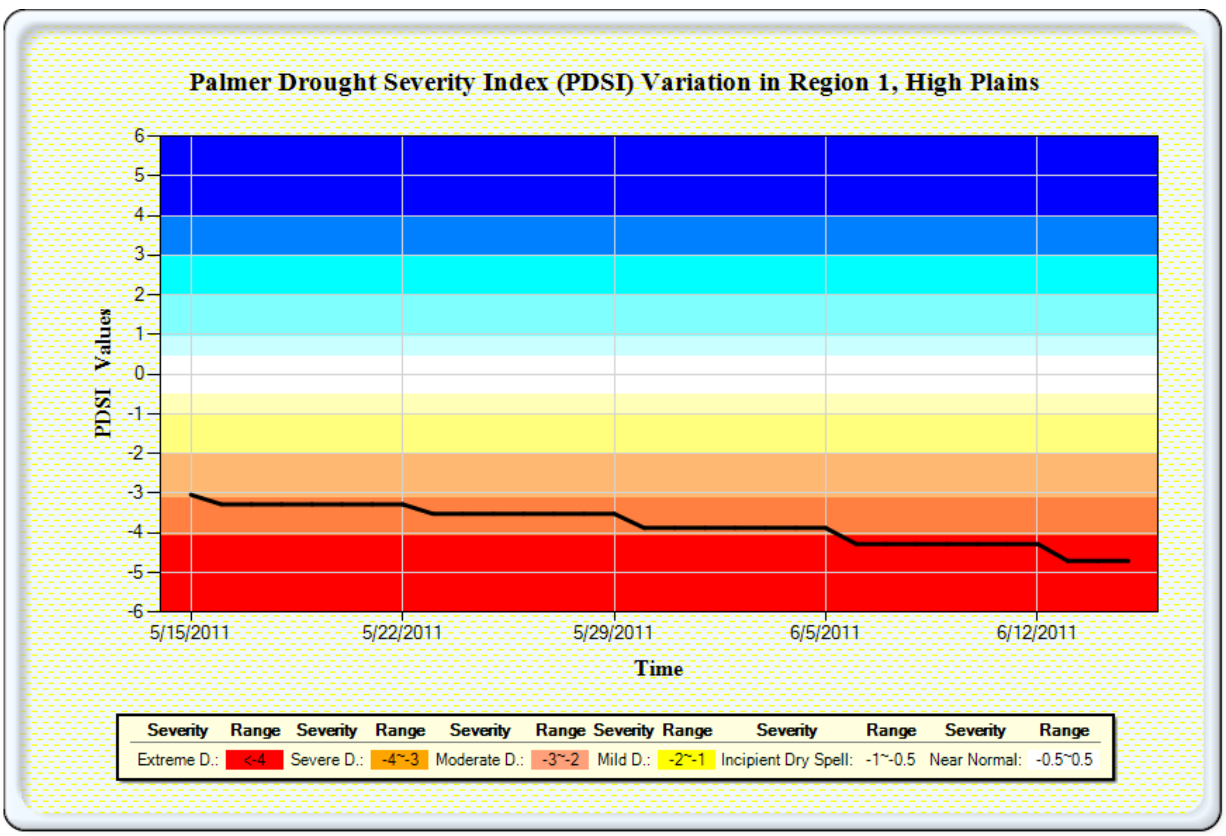
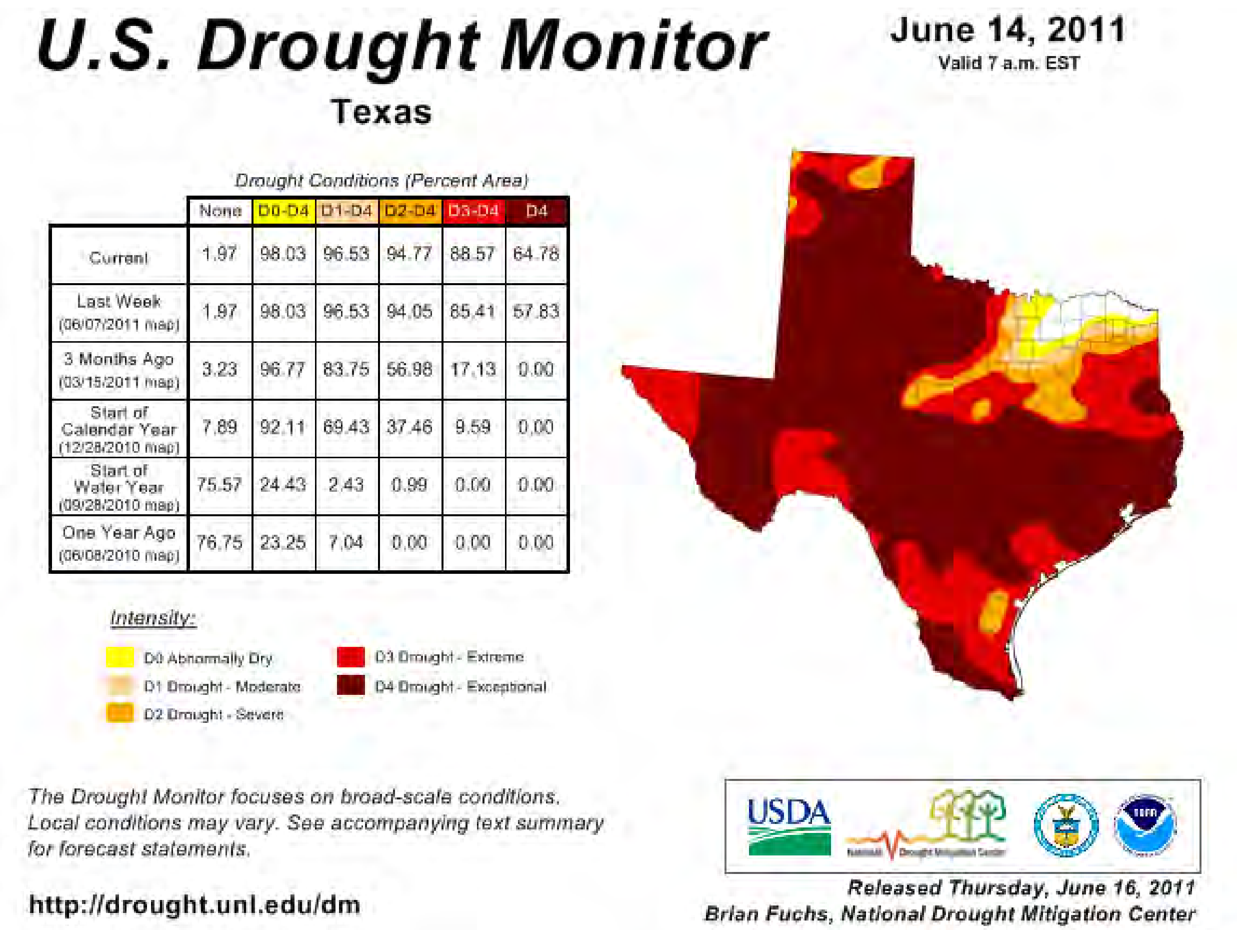


Figure 3. NOAA PDSI Depicting the Continuous Trend in the Severe Range.



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	1.97	98.03	96.53	94.77	88.57	64.78
Last Week (06/07/2011 map)	1.97	98.03	96.53	94.05	85.41	57.83
3 Months Ago (03/15/2011 map)	3.23	96.77	83.75	56.98	17.13	0.00
Start of Calendar Year (12/28/2010 map)	7.89	92.11	69.43	37.46	9.59	0.00
Start of Water Year (09/28/2010 map)	75.57	24.43	2.43	0.99	0.00	0.00
One Year Ago (06/08/2010 map)	76.75	23.25	7.04	0.00	0.00	0.00

Figure 4. NDMC Stage 4 Drought Condition for Bexar County.

4.1.5 Vegetation

The flora found in Bexar County is a mixture of the vegetation found in three biotic provinces; the Balconian (associated with the Edwards Plateau), the Texan (associated with the Blackland Prairie), and the Tamaulipan (associated with the South Texas Coastal Plain; **Table 1**). Prior to European settlement, the vegetation communities on the southeastern border of the Edwards Plateau were predominantly grasslands with woodlands and forests limited to hillsides and deeply incised limestone canyons (Weniger 1988). Current data, as provided by McMahan et al. (1984) in a detailed vegetation map of Texas, categorized the project area as urban. Although not a true vegetative community, urban areas contain mixed patches (i.e., lawns, gardens, etc.) of introduced cultivars and native vegetation.

Table 1
Vegetation Associated with All Three Biotic Provinces

Biotic Province	Associated Vegetation
Balconian Province[1]	Scrub forest (Mexican cedar, Texas oak, stunted live oak), Mesic forest (large live oaks, elms, hackberries, pecans), Mesquite throughout the region.
Texan Province[1]	Oak-hickory forests in sandy soils dominated by post oaks, blackjack oaks, and hickories. Tall-grass prairies in clay soils.
Tamaulipan Province[1]	Today - brushland dominated by thorny brush (mesquite, acacias, and mimosas), white brush, and prickly pear. Historically – grassland and savannah.[2]

[1] Source: Provinces per Blair (1950)
[2] Source: Inglis (1964)

4.1.6 Soils

The proposed project area is bisected by Leon Creek which meanders through the undeveloped floodplain and associated riparian areas containing five different soil types, one of which is historically occasionally flooded (Loire clay loam). The *Soil Survey of Bexar County, Texas,* (Taylor et al. 1991) was utilized to determine soil types found in the project area. Five soil types (**Table 2** and **Figure 2**) were mapped within the GG/CVIC proposed project alignments. Soil types occurring in the project area were compared to the Texas hydric soils list (NTCHS 2007). The National Technical Committee for Hydric Soils (NTCHS) does not list any of the soil types within the project area as having hydric characteristics. Hydric soils are formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (NTCHS 2007).

Table 2
Soil Types Associated with the GG/CVIC Project Corridors

Soil Series	Series Symbol	Soil Series Description
Lewisville silty clay, 0 to 1 percent slopes	LvA	This soil occurs on nearly level, broad terraces long rivers and creeks. The surface layer is silty clay or light clay and approximately 24 in thick. Very low erosion risk but considered very dry. Lack of soil moisture is a limitation for plants.

Table 2 (*continued*)
Soil Types Associated with the GG/CVIC Project Corridors

Soil Series	Series Symbol	Soil Series Description
Loire clay loam, 0 to 2 percent slopes, occasionally flooded	Fr	Listed as a hydric soil. This soil type is on flood plains on river valleys. The parent material consists of loamy alluvium. Depth to a root restrictive layer is greater than 60 in. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. This soil is occasionally flooded. It is not ponded. Organic matter content in the surface horizon is about 1 percent. This soil type can be described as a Loamy Bottomland.
Patrick soils, 3 to 5 percent slopes, rarely flooded	PaC	Occur as nearly level to gently sloping terraces along streams that drain limestone prairies. Mostly long and narrow, these soils are susceptible to erosion. The surface layer is clay loam, gravelly clay loam, silty clay, or light clay and is about 12 in thick.
Pitts and Quarries, 1 to 90 percent slopes	Pt	Consists of gravel pits, clay pits, sand pits, limestone quarries, chalk quarries, rock quarries and city dumps. Generally not suitable for agriculture.
Venus clay loam, 0 to 1 percent slopes	VcA	This soil occurs as smooth terrace 20 to 40 ft, above the flood plains of the San Antonio and Medina rivers and their main tributaries. This soil is limy and contains many snail shells, worm casts, and fine pores. The surface layer is about 16 in thick. The subsurface layer, about 20 in thick, is clay loam in texture but contains less clay than the surface layer.

in = inches; ft = feet
Source: Taylor et al. 1991

4.1.7 Topography

The topography within the project corridor is extremely varied, exemplified by a heterogeneous landscape composed of rises and falls within close proximity to each other as a result of severe disturbance that occurred in the past. The mean slope within the project corridor is 2.6 percent with a maximum of 16 percent using remotely sensed Digital Elevation Models (DEM) though localized surveying has concluded that some slope values may be as high as 60 percent. The elevation ranges from 700 ft above mean sea level (amsl) to 652 ft amsl with the lowest elevations along Leon Creek, in the southern portion of the survey area.

4.1.8 Hydrology

Hydrology within the project corridor was determined using three resources including FEMA FIRMs, USGS topographic maps, and CIR aerial photography.

4.1.8.1 Federal Emergency Management Agency and Flood Insurance Rate Map

The FEMA FIRMs provide information on the location of areas that are inundated from 100- and 500-yr flood events. The FEMA FIRMs show the area of land located in the bend of Leon Creek and some of the adjacent areas as being within the boundaries of the 100-yr floodplain. The areas depicted on **Figures 1**, **5** through **11**, and **Figures 1** through **8** in **Appendix C** of the FEMA FIRM 100-yr floodplain represents the flood areas that have a 1 percent chance of being equaled or exceeded in any given year.

4.1.8.2 United States Geological Survey and National Hydrography Dataset Maps

USGS topographic maps illustrate drainage patterns, ponds, and channels; however, the data are typically outdated and require field verification. The topographic map was used to assist in the identification of drainage patterns in and outside the corridors to determine if water features were isolated or adjacent to other waters. USGS map was also evaluated for evidence of modifications that could potentially alter water flow or collection (USGS 2009). The USGS 10-ft elevation contours are shown on **Figure 1**.

4.1.8.3 Natural Color and Color Infrared Aerial Photography

NC (**Figure 1**) and CIR (**Figure 12**) aerial imagery was used to assist in identifying water features such as streams, ponds, and other saturated areas based on the photograph's color signatures**.** The bright red color signatures produced by the vegetation that is associated with areas that are frequently inundated are only somewhat visible on the CIR aerial photographs. The most recent CIR aerial photography for the GG/CVIC area was produced in 2008; however, they are useful for determining areas that may be wetlands prior to conducting field surveys. Trained wetland biologists use NC aerial imagery to discern the location of changes in vegetation over large areas.

4.1.8.4 National Wetland Inventory

NWI maps are the only resource that specifically maps wetlands; however, this mapping is based on interpretation of small-scale aerial photographs which can result in errors due to differences in individual interpretation techniques. The NWI maps obtained prior to field surveys do not indicate that wetlands occur within the project corridors (**Figure 2**).

4.2 FIELD SURVEY RESULTS

4.2.1 Other Waters Delineated

Nine potential waters were delineated within the project corridor. The location of the water features are provided on 2008 NC aerial photographic maps (**Figures 5** through **11**) and in black and white on USGS topographic maps (**Figures 2** through **8**) in **Appendix C**. Representative photographs of the survey area, which includes photographs of delineated potential waters within the proposed project corridor, are provided in **Appendix B**. General descriptions of the potential waters delineated within the GG/CVIC project corridor are listed below.

Water 1 is an ephemeral drainage that measures 31 ft long, averages around 6.5 ft wide at the OHWM, and totals 0.0047 ac. Water 1 flows in a north to south direction toward Leon Creek; its elevation changes from 700 to 696 ft asml. The soil in Water 1 is comprised of Venus Clay Loam having a 0 to 1 percent slope. Water 1 is unaltered in the project corridor; however, north of the project corridor, the water flow has been altered due to a developed/industrial area. During the field survey, Water 1 was delineated based on the change in topography, litter bars, and water-stained leaves located in the channel and a change in vegetation. Outside of the ephemeral drainage there is a lack of any vegetation, but inside the channel area, vegetation is present. The vegetation community in the channel is composed mainly of weedy annual species. Water 1 is not located in the 100-yr floodplain of Leon Creek where it crosses the project corridor; however, south of the project corridor, it does enter the 100-yr floodplain. The channel is visible on the aerial photography and can be seen continuing south outside of the project corridor to Leon Creek. Water 1 is not visible on the NWI map. The OHWM delineation is based on matted down vegetation and a change in the plant community. Other factors used to determine the OHWM for Water 1 are drift lines and the associated drainage patterns (**Figure 5 and Appendix C: Figure 2).**

Water 2 is also an ephemeral drainage. Within the project corridor, it measures 23 ft long, has an average width of 4.5 ft, and totals 0.0015 ac. As in Water 1, the soil in Water 2 is Venus Clay Loam, 0 to 1 percent slope. Water 2 is unaltered in the project corridor, but is altered north of the project corridor. There is also evidence of water drainage and water flow north of the project area; however, there is no distinguishable OHWM.

Water 2 flows north to south toward Leon Creek with an elevation change from 700 to 696 ft amsl. The vegetation changes with the topography and there is a downstream connection. Water 2 is not visible on the NWI and is not located in the 100-yr floodplain where it crosses the project corridor; however, it does enter the 100-yr floodplain south of the corridor. The channel can be seen from aerial photography and can be seen continuing outside the project corridor south to Leon Creek. Creek drainage is visible north of the project corridor as well. The OHWM delineation is based on destruction of terrestrial vegetation, and absent vegetation. There are exposed rocks in the drainage where the water has washed soil downstream. There is minor buttressing on the few trees in the channel. Other important field factors used to delineate Water 2 are water marks, sediment deposits, water-stained leaves, and drainage patterns. Outside of the project corridor, Water 2 becomes much wider and is highly eroded downstream (**Figure 5** and **Appendix C: Figure 2**).

Water 3 is 84.5 ft long, averages 5.5 ft wide, and covers 0.0057 ac. The soil in Water 3 is Venus Clay Loam, 0 to 1 percent slope. Water 3 is unaltered within the project corridor, but is altered north of the project corridor. There is an ephemeral drainage and evidence of water flow originating north of the project corridor. Water 3 flows north to south toward Leon Creek with an elevation change from 700 to 696 ft amsl. The vegetation of Water 3 changes with the topography and has a downstream connection. Water 3 is not identified on the NWI. Water 3 is not located in the 100-yr floodplain in the project corridor; however, it does enter the 100-yr floodplain south of the project corridor. Water 3 can be seen on the aerial photography and can be seen continuing south, outside the project corridor, toward Leon Creek. The OHWM delineation is based on destruction of terrestrial vegetation, absent vegetation, and exposed rocks in the drainage where the water has washed soil downstream. Other factors used in the delineation of Water 3 are water marks, sediment deposits, water-stained leaves, and drainage patterns (**Figure 5** and **Appendix C: Figure 2**).

Water 4 is 14 ft long, averages 10 ft wide, and covers 0.0026 ac. The soil in Water 4 is Venus Clay Loam with a slope of 0 to 1 percent. The channel flows northeast to southwest toward Leon Creek with an elevation change from 690 to 684 ft amsl. Water 4 is very distinct on the topographical lines and was visible during the field visit. Field biologists confirmed that Water 4 continues outside of the project corridor. Water 4 is not identified on the NWI. The FEMA FIRM shows the entire channel is located within the Leon Creek 100-yr floodplain. Water 4 can be seen on the aerial photography and it can also be seen continuing to the southwest outside of the corridor. The OHWM delineation is based upon shelving, scouring, and extreme and active erosion. Other important field factors noted during the field survey were the drainage patterns and the large debris, such as tires, a mattress, and other unidentified garbage, transported by massive water flow events, (**Figure 6** and **Appendix C: Figure 3**).

Water 5 is an ephemeral drainage measuring 114 ft in length and averaging 13 ft in width at the OHWM with an area of 0.0198 ac. Water 5 flows northeast to southwest toward Leon Creek with an elevation ranging from 690 ft to 678 ft amsl. Topographic variation can be seen on the USGS maps and was verified in the field Water 5 is altered and receives water flow from a culvert that drains the LAFB flight line from the east. Ten percent of the soil in Water 5 is comprised of Loire clay loam, with 0 to 2 percent slope, and 90 percent of the soil composition within Water 5 is comprised of Venus clay loam, with 0 to 1 percent slope. Important indicators present during the field surveys were a change in vegetation, the connection to Leon Creek downstream, water-stained leaves, and drainage patterns. Water 5 is not located within the 100-yr floodplain of Leon Creek according to spatial mapping information, yet the spatial association with hydrologic and geomorphic features and proximity to the 100-yr floodplain suggest that it may be included. Water 5 is visible on aerial photography, continuing both to the northeast to Growdon Road and southwest of the project corridor to Leon Creek. Water 5 is not visible on the NWI map. The OHWM delineation was based on shelving, destruction of terrestrial vegetation, the presence of litter and debris, the absence of vegetation, and soil deposition (**Figure 7** and **Appendix C: Figure 4**).

Water 6 is an ephemeral drainage measuring 718 ft in length and averaging 19 ft in width at the OHWM producing an area of 0.2398 ac. Water 6 flows north to south with an elevation range of 682 ft at the top of the embankments to 660 ft and eventually connects to Leon Creek. It is illustrated in the NHD, can be seen on aerial imagery both up and downstream, and is described on NWI maps as “R4SBAx.” This classification indicates that it is an intermittent riverine system with a temporarily flooded streambed that has been excavated. It is a naturalized man-made canal that replaced a historic channel. Soil composition within Water 6 is Lewisville silty clay, with 0 to 1 percent slope and is occasionally flooded. Topographic variation can be seen on the USGS maps and was verified in the field. The water connects downstream to Leon Creek. The southern 0.1410 ac of the 0.2398 ac of Water 6 falls within the 100-yr floodplain. The OHWM was delineated in the field based on vegetation change associated with topography as well as bent vegetation due to fluvial influence. Other important field factors include sediment deposits, drift lines, water-stained leaves, drainage patterns, geomorphic position, and aquatic vegetation found in the channel where water was ponded (**Figure 8** and **Appendix C: Figure 5**).

Water 7 is a perennial channel measuring 114.75 ft in length and averaging 54.6 ft in width at the OHWM totalling an area of 0.1302 ac. Water 7 is Leon Creek, an unaltered channel flowing from southwest to northeast at this crossing. The soil type within Water 7 is Loire clay loam, with 0 to 2 percent slope, which is occasionally flooded. Elevation ranges from 666 ft amsl at the top of the embankment to 662 ft amsl at the channel bottom. It is illustrated in the NHD, can be seen on aerial imagery both up and downstream, and is described on NWI maps as “R2UBH.” This classification indicates that it is a lower perennial riverine system with an unconsolidated bottom that is permanently flooded. Topographic variation can be seen on the USGS maps and was verified in the field. Water 7 is located entirely within the 100-yr floodplain and was confirmed to have a hydrologic connection downstream by the field biologists. OHWM was delineated based on the clear natural line impressed on the bank, shelving, the presence of litter and debris, bed and banks, as well as an observed flow event during the field surveys. (**Figure 9** and **Appendix C: Figure 6**).

Water 8 is an ephemeral drainage measuring 197.61 ft in length and averaging 31.59 ft in width, totaling 0.0809 ac. Water 8 (also Leon Creek) flows northeast to southwest at this crossing with a variation in elevation ranging from 658 ft amsl at the top of the embankment to 656 ft amsl at the drainage bottom. Water 8 shows a hydrologic connection both up and downstream of its location and is completely within the 100-yr floodplain. According to the Bexar County Soil Survey, 40 percent of the soil composition within Water 8 is Pits and Quarries, with 1 to 90 percent slope and 60 percent of the soil composition is Loire clay loam, with 0 to 2 percent slope and in an altered state. Topographic variation can be seen on the USGS maps and was verified in the field. The vegetation contrasts in comparison to the surrounding environment by being absent in the drainage. Recognition of this feature through the use of aerial imagery is possible due to the void in vegetation. OHWM was delineated based on shelving, the destruction of terrestrial vegetation, the presence of litter and debris, the absence of vegetation, leaf litter disturbed or washed away, scouring, and the presence of bed and bank features. Important field indicators were surface water within the drainage, water marks, and fluvial drainage patterns (**Figure 11** and **Appendix C: Figure 8**).

Water 9 is a perennial channel measuring 168.5 ft in length and averaging 12.5 ft in width with an area of 0.0530 ac. Water 9 flows west to east and ranges in elevation from 654 ft amsl at the top of the embankment to 652 ft amsl at the bottom of the channel. Water 9 lies within an altered portion of Leon Creek, which is characterized by NWI as “R2UBh” and is within the 100-yr floodplain. This classification indicates that it is a lower perennial riverine system with an unconsolidated bottom that is diked or impounded. Connection downstream is not clearly defined as it has been altered through the use of culverts. Soil composition of Water 9 is Loire clay loam, with 0 to 2 percent slope that is occasionally flooded. Soil change was observed along embankments adjacent to the channel exhibiting higher levels of silt content Topographic variation can be seen on the USGS maps and was verified in the field. Vegetation change was apparent and associated with topography, as areas of lower elevation were inundated by water and contained aquatic varieties of flora. OHWM was delineated based on changes in the character of the soil composition, destruction of terrestrial vegetation, the presence of litter and debris, wracking, matted vegetation that was bent due to fluvial activity, and sediment sorting. Leaf litter was disturbed or washed away, scouring, deposition, water staining, and the change in plant community also contributed to the delineation of the OHWM. Important field factors were water marks, drift lines, surface water, and drainage patterns (**Figure 11** and **Appendix C: Figure 8**).

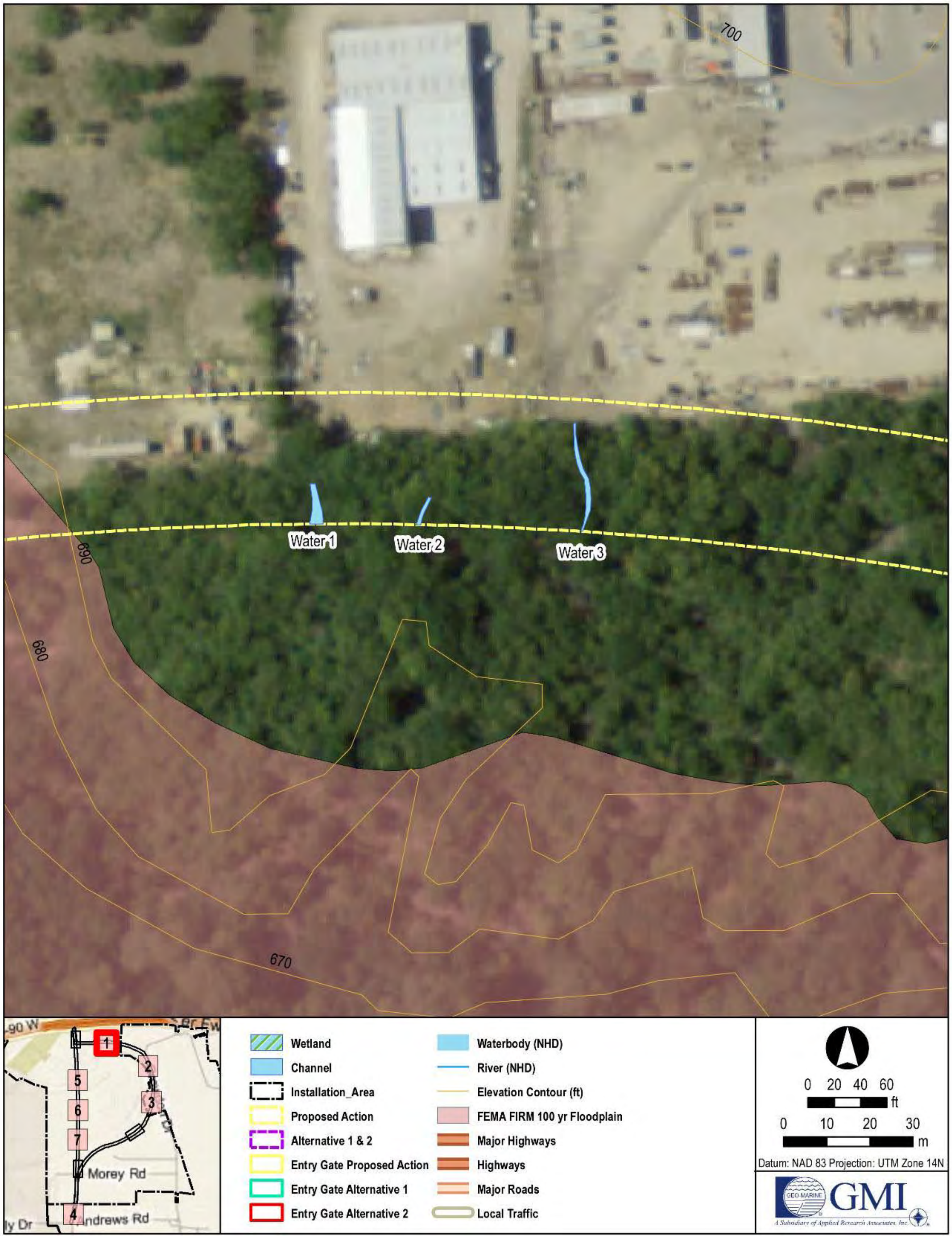


Figure 5. Project Route (Layout 1 of 7) consisting of Waters 1, 2, and 3.

Figure 6. Project Route (Layout 2 of 7) consisting of Water 4.

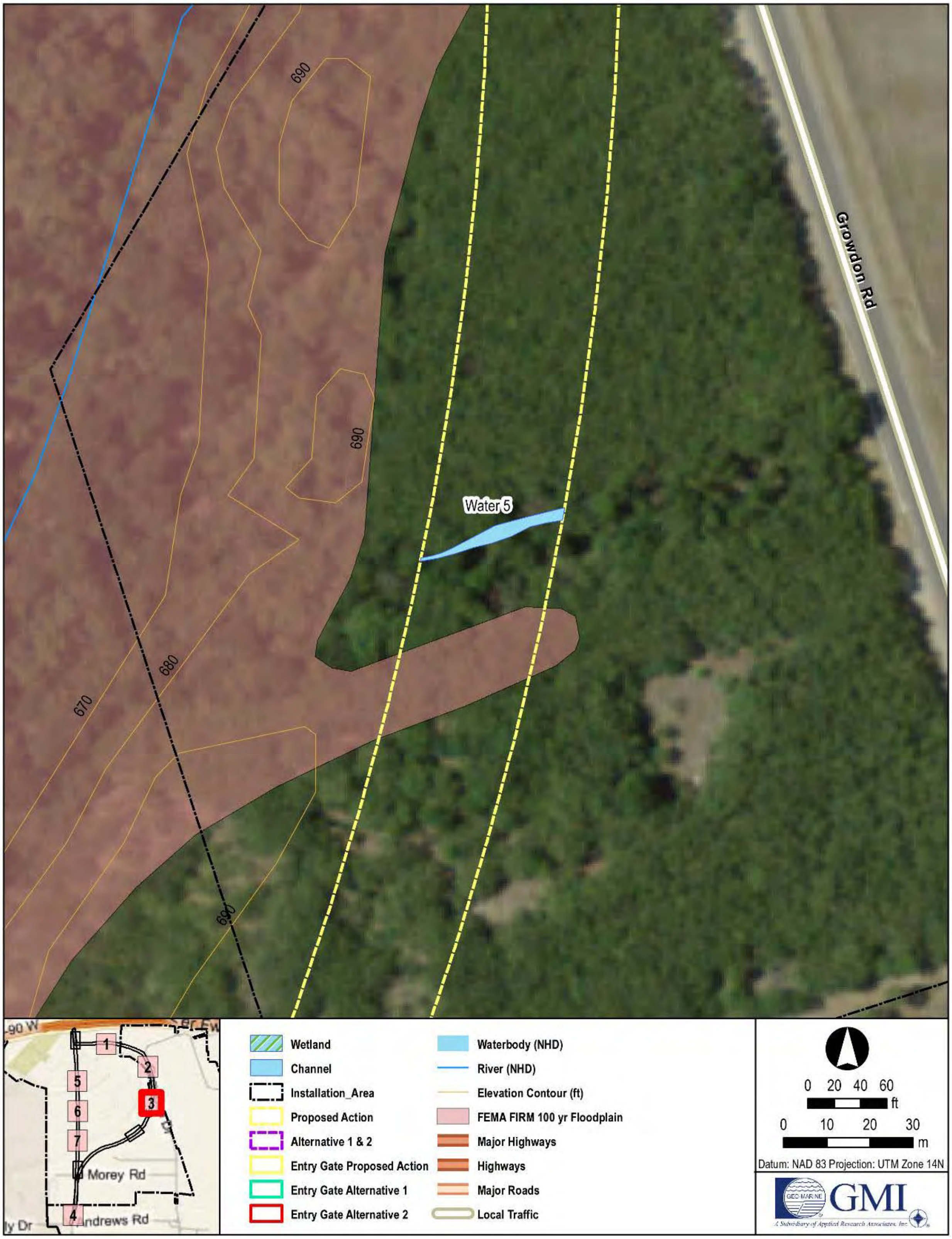


Figure 7. Project Route (Layout 3 of 7) consisting of Water 5.

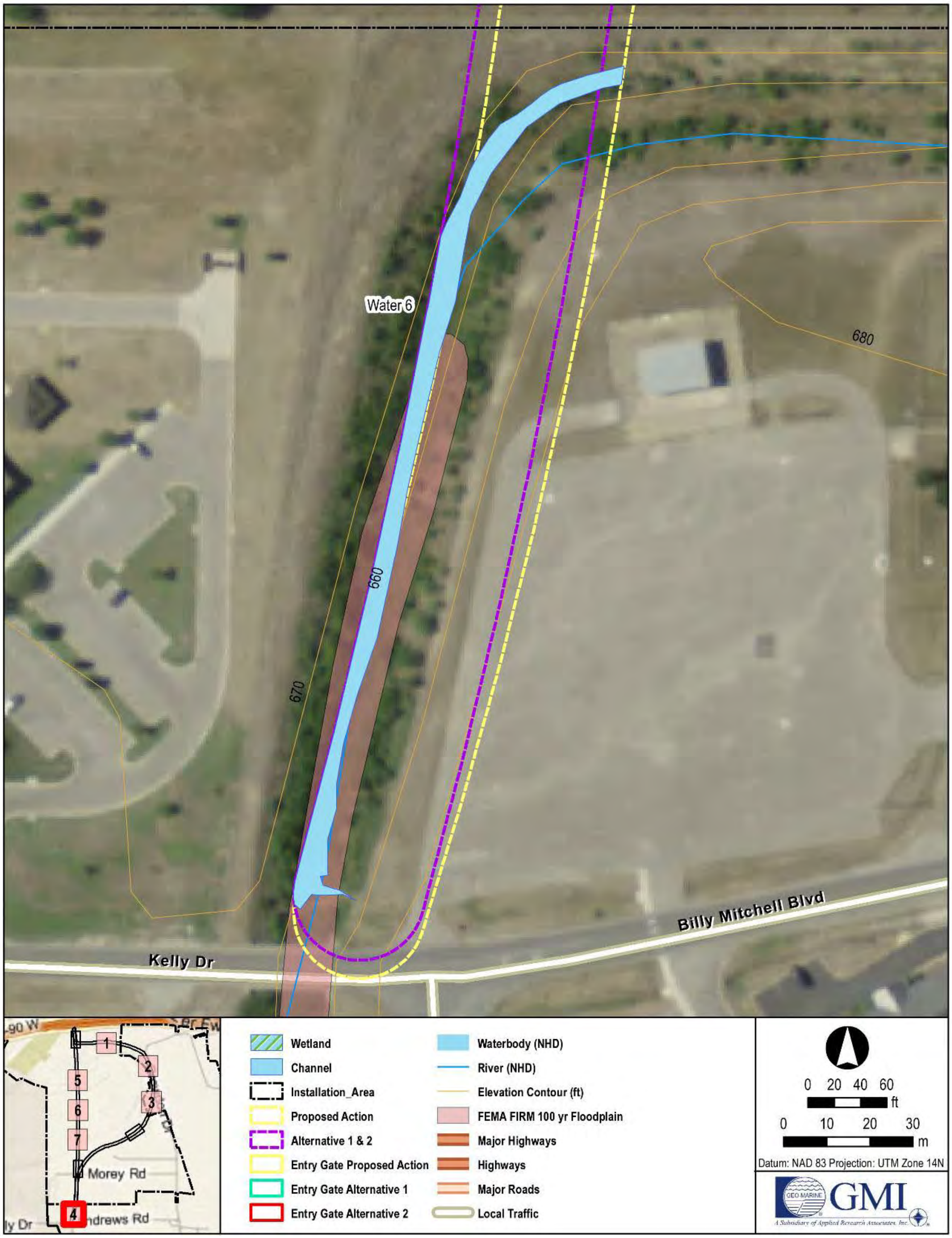


Figure 8. Project Route (Layout 4 of 7) consisting of Water 6.

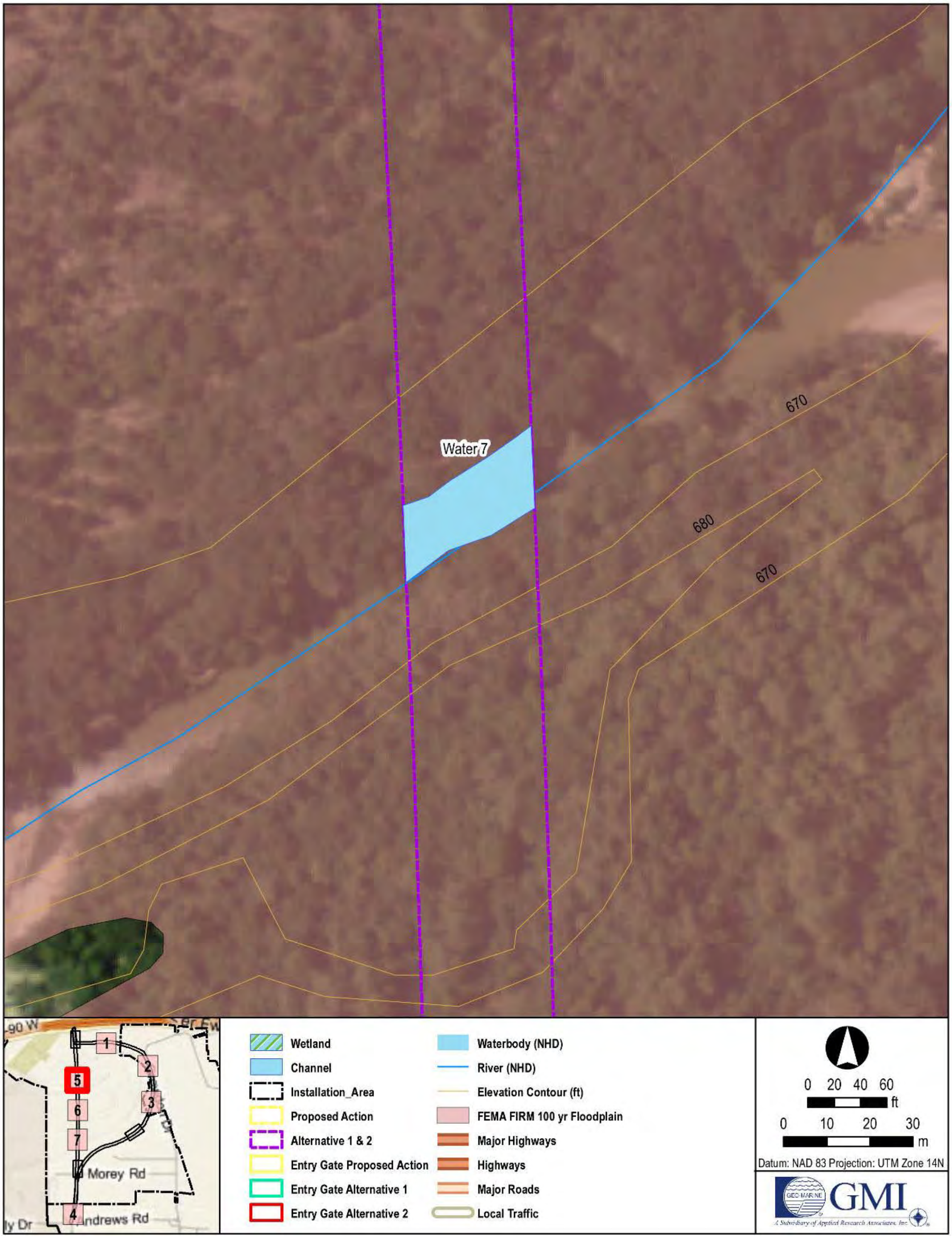


Figure 9. Project Route (Layout 5 of 7) consisting of Water 7.

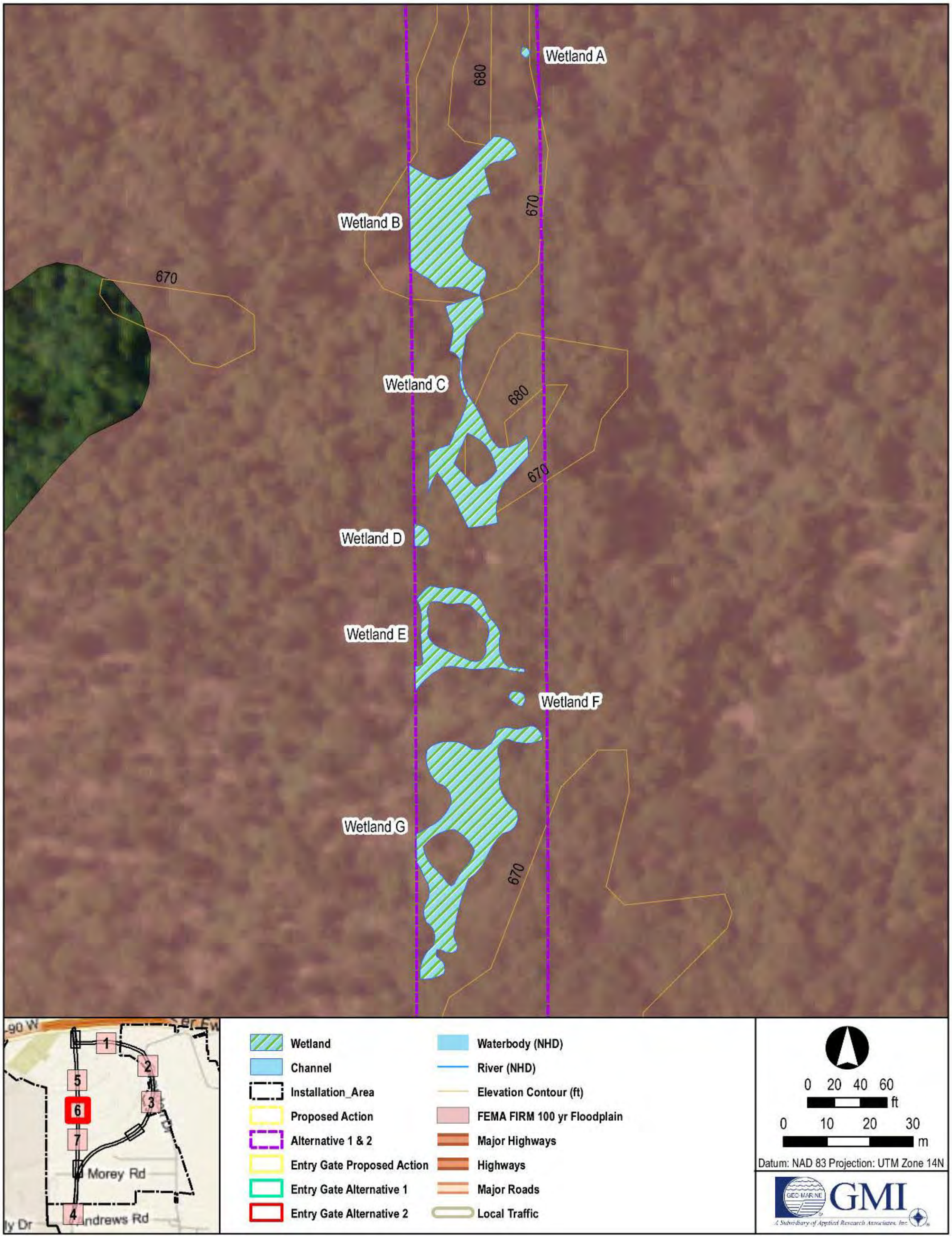


Figure 10. Project Route (Layout 6 of 7) consisting of Wetlands A through G.

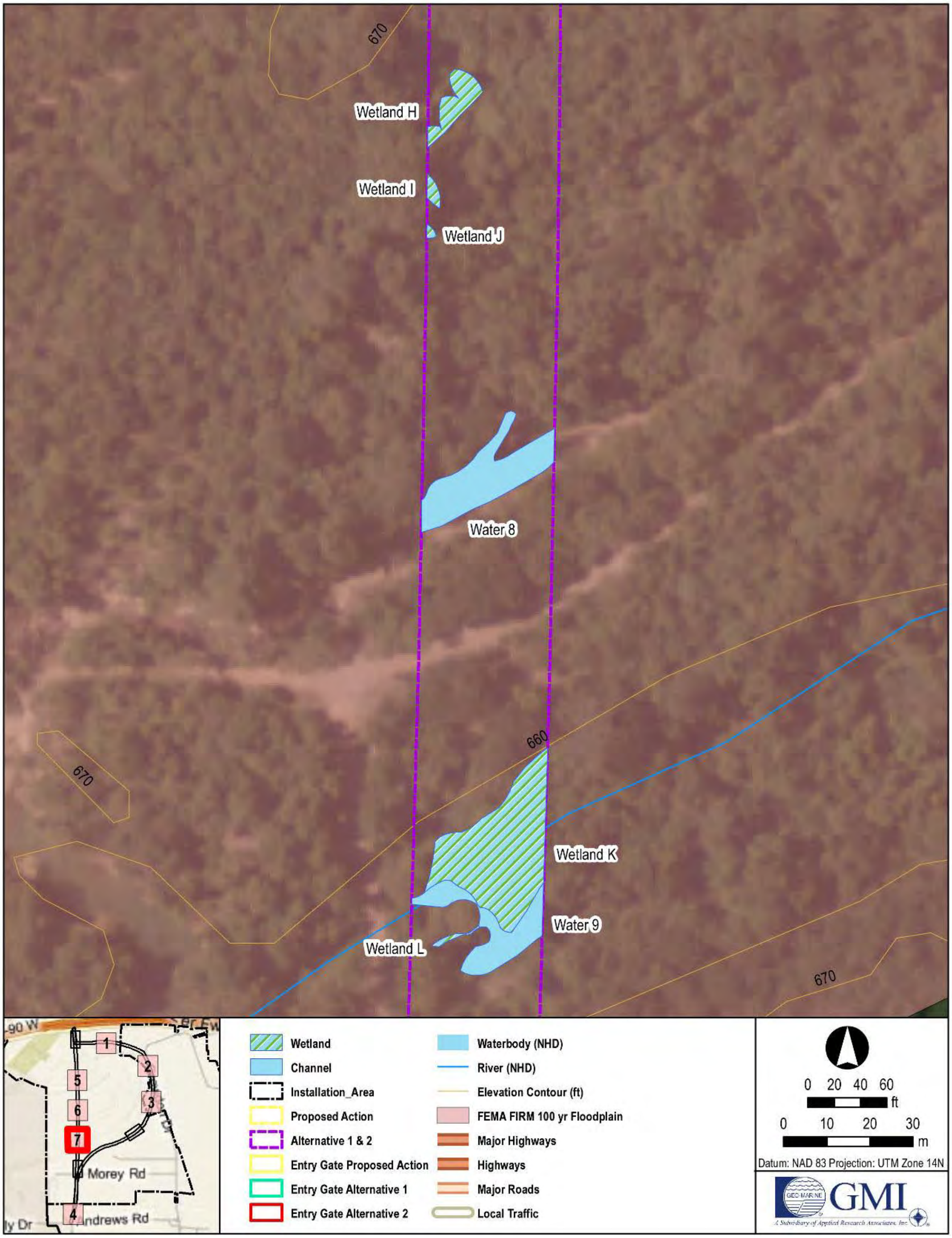


Figure 11. Project Route (Layout 7 of 7) consisting of Waters 8 and 9 and Wetlands H through L.

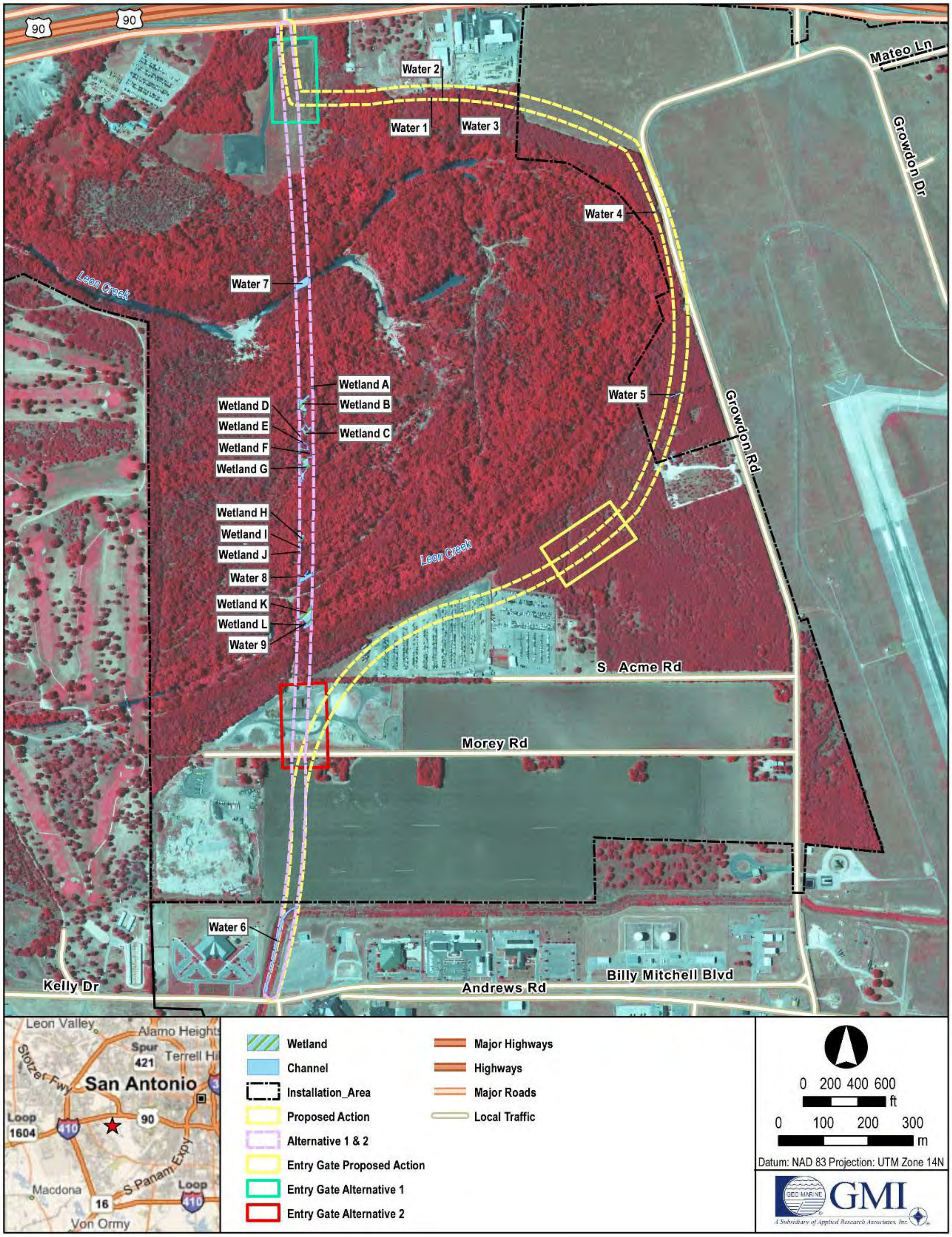


Figure 12. CIR Aerial Overview with Waters and Wetland Findings within the Proposed GG/CVIC Project Corridor.

4.2.2 Wetlands Delineated

During the field survey, 12 potential wetlands were located and delineated within the project corridors. The delineation and location of these potential wetlands are provided on 2008 NC aerial photographic maps (**Figures 10** and **11**) and in black and white on USGS topographic maps (**Figures 7** and **8**) in **Appendix C**. Representative photographs of the survey area, which include photographs of delineated waters within the proposed project corridor, are provided in **Appendix B.** General descriptions of the potential wetlands delineated within the GG/CVIC project corridor are listed below.

Wetland A covers 0.0010 ac and is located in the 100-yr floodplain. The soil type of Wetland A is Pits and Quarries, with a 1 to 90 percent slope. The soil consists of 0 to 3.5 in of silty clay with gravel interspersed. The Munsell® Soil Color Charts (1994) were used to determine the redox color, which was 10YR 3/2. From 3.5 to 12.0 in is silty clay loam with a redox color 7.5YR 3/1. The soil has possibly been altered because of past mining operations on the site. Wetland A is a small low-lying area that appears to be jointed to other wet areas outside the project corridor. The elevation is between 662 ft amsl and 664 ft amsl. There are many topographical changes in the vicinity indicating water flow and the channeling of water in the area. There is more silt in the wetland area compared to the area upland. Wetland A is not indicated on the NWI map and is not visible on the NC aerial photography due to the thick canopy cover; however, the CIR shows the area as a brighter red indicating that water could be present or hydric conditions could exist. There is approximately 85 percent bareground in the herbaceous stratum of the wetland area. The OHWM delineation is based on the change in the plant community. There are faint oxidized rhizospheres along the living roots below 3.5 in. Important field indicators are the existence of an algal crust, water-stained leaves, and a sparsely vegetated, concave surface. The vegetative transition along the OHWM is beginning to become blurred because of the drought conditions. There is another wetland adjacent to Wetland A, but it is outside the project corridor. The adjacent wetland has very distinct water marks on the trees growing in the wetland. It appears the area was disturbed by some type of large scale mechanical operation in the past; however, the area has been undisturbed for a length of time significant enough to allow the area to naturalize.

Wetland B covers 0.1091 ac and is located in the 100-yr floodplain. The soil type of Wetland B is Pits and Quarries, with a 1 to 90 percent slope. The soil at 0 to 3.5 in of silty clay with gravel mixed in. The redox color is 10YR 3/2. There is decaying matter layered into the soil. At 3.5 to 6.0 in the soil starts to gley. Gleyed soils develop when anaerobic soil conditions result in pronounced chemical reduction of iron, manganese and other elements, thereby producing gray soil colors. Anaerobic conditions that occur in waterlogged soils result in the predominance of reduction processes, and such soils are greatly reduced. Iron is one of the most abundant elements in soils. Under anaerobic conditions, iron is converted from the oxidized state to the reduced state, which results in the bluish, greenish or grayish colors associated with the gleying effect. There is a small amount of oxidation occurring, and small bits of black clay evident. The soil at 6 to 18 in has redox color of 5YR 5/8, approximately a 100 percent increase. The elevation of Wetland B is approximately 660 to 662 ft. Topographic variation can be seen on the USGS maps and was verified in the field. Wetland B is very low compared to surrounding areas, inundated, and the OHWM is down approximately 4.5 ft from its typical location. Wetland B is not indicated on the NWI map and is not visible on the NC aerial photography due to the thick canopy cover; however, the CIR shows the area as a brighter red indicating that water could be present or hydric conditions could exist. There is no vegetation growing in Wetland B. The OHWM delineation is based on a clear natural line impressed on the edge, the presence of litter and debris and the absence of vegetation. Other important field factors that exist are surface water, water marks, sulfide odor, the presence of mosquitoes, and its geomorphic position. Several amphibians were noted during the field survey including a few young toads (*Bufo* species [spp.]), leopard frogs (*Rana* spp.) and three ground skinks (*Scincella lateralis*) that were found near the water's edge.

Wetland C covers 0.0830 ac and is located in the 100-yr floodplain. The soil type of Wetland C is Pits and Quarries, with a 1 to 90 percent slope. The soil at 0 to 3 in is silty, sandy clay. The redox color is 7.5YR 3/1 with a mottle color of 2.5YR 4/8 at approximately 5 percent. The soil at 4 to 12 in is a gravelly clay loam. The redox color is 7.5YR 2.5/1 with a mottle color of 7.5YR 6/6 at approximately 30 percent. Wetland C is a low-lying area located at the base of the highly topographic upland mounds. The surrounding elevation varies greatly. There is no vegetation in the wetland. The soil changes with the topography with the uplands lacking moisture and having a more sandy composition. Wetland C is not indicated on the NWI map and is not visible on the NC aerial photography due to the thick canopy cover; however, the CIR shows the area as a brighter red indicating that water could be present or hydric conditions could exist. The OHWM delineation is based upon changes in the character of the soil and destruction of terrestrial vegetation. Other important field factors present are oxidized rhizospheres, a concave surface, and its geomorphic position.

Wetland D covers 0.0036 ac and is located in the 100-yr floodplain. The soil type of Wetland D is Pits and Quarries, with a 1 to 90 percent slope. The soil at 0 to 3 in is silty, sandy clay. The redox color is 7.5YR 3/1 with a mottle color of 2.5YR 4/8 at approximately 5 percent. The soil at 4 to 12 in is a gravelly clay loam. The redox color is 7.5YR 2.5/1 with a mottle color of 7.5YR 6/6 at approximately 30 percent. Wetland D is a low-lying area located at the base of the highly topographic upland mounds. The elevation varies greatly. There is no vegetation in the wetland. The soil changes with the topography, with the uplands lacking moisture and having a more sandy composition. Wetland D is not indicated on the NWI map and is not visible on the NC aerial photography due to the thick canopy cover; however, the CIR shows the area as a brighter red indicating that water could be present or hydric conditions could exist. The OHWM delineation is based upon changes in the character of the soil and destruction of terrestrial vegetation. Other indicators are oxidized rhizospheres, a concave surface, and its geomorphic position.

Wetland E covers 0.0433 ac and is located in the 100 yr floodplain. The soil type of Wetland E is Pits and Quarries, with a 1 to 90 percent slope. The soil at 0 to 3 in is silty, sandy clay. The redox color is 7.5YR 3/1 with a mottle color of 2.5YR 4/8 at approximately 5 percent. The soil at 4 to 12 in is a gravelly clay loam. The redox color is 7.5YR 2.5/1 with a mottle color of 7.5YR 6/6 at approximately 30 percent. Wetland E is a low-lying area located at the base of the highly topographic upland mounds. The elevation varies greatly. There is no vegetation in the wetland except for water plantain (*Alisma* spp.) growing in the center. Some vegetation exists around the perimeter of the wetland. The soil changes with the topography, with the uplands lacking moisture and having a more sandy composition. Wetland E is not indicated on the NWI map and is not visible on the NC aerial photography due to the thick canopy cover; however, the CIR shows the area as a brighter red indicating that water could be present or hydric conditions could exist. The OHWM delineation is based upon changes in the character of the soil, and destruction of terrestrial vegetation. Other important field factors are oxidized rhizospheres, a concave surface, and its geomorphic position.

Wetland F covers 0.0433 ac and is located in the 100-yr floodplain. The soil type of Wetland F is Pits and Quarries, with a 1 to 90 percent slope. The soil at 0 to 3 in is silty, sandy clay. The redox color is 7.5YR 3/1 with a mottle color of 2.5YR 4/8 at approximately 5 percent. The soil at 4 to 12 in is a gravelly clay loam. The redox color is 7.5YR 2.5/1 with a mottle color of 7.5YR 6/6 at approximately 30 percent. Wetland F is a low-lying area located at the base of the highly topographic upland mounds. The elevation varies greatly. There is no vegetation in the wetland. The soil changes with the topography, with the uplands lacking moisture and having a more sandy composition. Wetland F is not indicated on the NWI map and is not visible on the NC aerial photography due to the thick canopy cover; however, the CIR shows the area as a brighter red indicating that water could be present or hydric conditions could exist. The OHWM delineation is based upon changes in the character of the soil and the lack of terrestrial vegetation. Other important field factors are oxidized rhizospheres, a concave surface, and its geomorphic position.

Wetland G is located in the 100-yr floodplain and totals 0.1434 ac in size. The soil type of Wetland G is Pits and Quarries, with a 1 to 90 percent slope. The soil at 0 to 3 in is silty, sandy clay. The redox color is 7.5YR 3/1 with a mottle color of 2.5YR 4/8 at approximately 5 percent. The soil at 4 to 12 in is a gravelly clay loam. The redox color is 7.5YR 2.5/1 with a mottle color of 7.5YR 6/6 at approximately 30 percent. The soil is extremely moist with some vegetation present. The OHWM delineation is based upon changes in the character of the soil and the destruction of terrestrial vegetation.

Wetland H covers 0.0217 ac and is located in the 100-yr floodplain. The soil type of Wetland H is Pits and Quarries, with a 1 to 90 percent slope. The soil at 0 to 3 in is silty, sandy clay. The redox color is 7.5YR 3/1 with a mottle color of 2.5YR 4/8 at approximately 5 percent. The soil at 4 to 12 in is a gravelly clay loam. The redox color is 7.5YR 2.5/1 with a mottle color of 7.5YR 6/6 at approximately 30 percent. The soil is extremely moist with some vegetation present. Wetland H is a low-lying area located at the base of the highly topographic upland mounds. The elevation varies greatly. The soil changes with the topography, with the uplands lacking moisture and having a more sandy composition. Wetland H is not indicated on the NWI map and is not visible on the NC aerial photography due to the thick canopy cover; however, the CIR shows the area as a brighter red indicating that water could be present or hydric conditions could exist. The OHWM delineation is based upon changes in the character of the soil and the destruction of terrestrial vegetation. Wetland H appears to connect to Wetland I and J outside the project corridor.

Wetland I covers 0.0037 ac and is in the 100-yr floodplain. The soil type is Loire clay loam with a 0 to 2 percent slope, occasionally flooded. This soil is considered to be hydric by the NCTHS. Wetland I is a low-lying area located at the base of the highly topographic upland mounds. The elevation varies greatly. The soil changes with the topography, with the uplands lacking moisture and having a more sandy composition. Wetland I is not indicated on the NWI map and is not visible on the NC aerial photography due to the thick canopy cover; however, the CIR shows the area as a brighter red indicating that water could be present or hydric conditions could exist. The OHWM delineation is based upon changes in the character of the soil and the destruction of terrestrial vegetation. Wetland I appears to connect to Wetland H and J outside the project corridor.

Wetland J covers 0.0010 ac and is in the 100-yr floodplain. The soil type is Loire clay loam with a 0 to 2 percent slope, occasionally flooded. This soil is considered to be hydric by the NCTHS. Wetland J is a low-lying area located at the base of the highly topographic upland mounds. The elevation varies greatly. The soil changes with the topography, with the uplands lacking moisture and having a more sandy composition. Wetland J is not indicated on the NWI map and is not visible on the NC aerial photography due to the thick canopy cover; however, the CIR shows the area as a brighter red indicating that water could be present or hydric conditions could exist. The OHWM delineation is based upon changes in the character of the soil and the destruction of terrestrial vegetation. Wetland J appears to connect to Wetland H and I outside the project corridor.

Wetland K covers 0.1472 ac and is in the 100-yr floodplain. The soil type is Lewisville silty clay, with a 0 to 1 percent slope. The area appears to have been altered. Wetland K elevation is approximately 650 to 652 ft. Wetland K appears on the NWI map as Leon Creek. Wetland K is not visible on the NC aerial photography due to the thick canopy cover; however, the CIR shows the area as a brighter red indicating that water could be present or hydric conditions could exist. The OHWM delineation is based on the change in plant community. Other important field factors are surface water, water marks, and drift lines. Wetland K is a large, established wetland that continues outside the project corridor. The vegetation in Wetland K has an extremely different species composition than any of the other wetlands found in the project corridor.

Wetland L covers 0.002 ac and is in the 100-yr floodplain. The soil type is Lewisville silty clay, with a slope of 0 to 1 percent slope. Wetland L appears on the NWI map as Leon Creek. Wetland L is not visible on the NC aerial photography due to the thick canopy cover; however, the CIR shows the area as a brighter red indicating that water could be present or hydric conditions could exist. The OHWM delineation is based on the change in plant community. Wetland L is connected to Wetland K by Water 9.

Figure 12 provides a CIR aerial overview of the waters and wetland findings within the proposed GG/CVIC project corridor.

Table 3 provides a quantitative summary of the potential wetlands and waters delineated within the project corridor.

Table 3
Delineated Potential Waters and Wetlands of the U.S.
Within the GG/CVIC Project Corridor

Feature Name	Type	Area (ac)	Length (ft)
Water 1	Channel	0.0048	32.00
Water 2	Channel	0.0015	23.00
Water 3	Channel	0.0057	84.50
Water 4	Channel	0.0026	14.00
Water 5	Channel	0.0198	114.00
Water 6	Channel	0.2398	718.00
Water 7	Channel	0.1302	114.75
Water 8	Channel	0.0809	179.61
Water 9	Channel	0.0530	168.50
TOTAL WATERS		**0.5383**	**1,448.36**

Table 3 (*continued*)
Delineated Potential Waters and Wetlands of the U.S.
Within the GG/CVIC Project Corridor

Feature Name	Type	Area (ac)	Length (ft)
Wetland A	Wetland	0.0010	N/A
Wetland B	Wetland	0.1091	N/A
Wetland C	Wetland	0.0830	N/A
Wetland D	Wetland	0.0036	N/A
Wetland E	Wetland	0.0433	N/A
Wetland F	Wetland	0.0022	N/A
Wetland G	Wetland	0.1434	N/A
Wetland H	Wetland	0.0217	N/A
Wetland I	Wetland	0.0037	N/A
Wetland J	Wetland	0.0010	N/A
Wetland K	Wetland	0.1472	N/A
TOTAL WETLANDS	**-**	**0.5592**	**N/A**

N/A = Not Applicable

Table 4 provides a summary of the potential wetlands and waters of the U.S. for Proposed Action and each of the Alternatives.

Table 4
Summary of Impacts for the Proposed Action and Alternatives

ACTION	AREA (ac)	LENGTH (ft)
Proposed Action		
Waters	0.2742	985.5000
Wetlands	0	N/A

Table 4 *(continued)*
Summary of Impacts for the Proposed Action and Alternatives

Alternative 1		
Waters	0.5039	1180.8600
Wetlands	0.5592	N/A
Alternative 2		
Waters	0.5039	1180.8600
Wetlands	0.5592	N/A

5.0 CONCLUSIONS

Agencies that regulate impacts to the nation's water resources within Texas include the USACE, the U.S. Environmental Protection Agency (USEPA), the U.S. Fish and Wildlife Service (USFWS), and the Texas Commission on Environmental Quality (TCEQ). Jurisdictional waters of the U.S. are protected under guidelines outlined in Sections 401 and 404 of the CWA (**Table 4**), in EO 11990 (Protection of Wetlands), and by the review process of the TCEQ. The USACE has the primary regulatory authority for enforcing Section 404 requirements for waters and wetlands of the U.S.

Jurisdictional waters are all features with an OHWM or wetlands that have all three wetland parameters that meet the definition of a water of the U.S. in 33 CFR 328.3. **Table 4** provides the definitions of waters of the U.S. according to 33 CFR 328.3a.

Table 5
Definition of Waters of the U.S.

Definition Number	Definition
1	All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
2	All interstate waters including interstate wetlands;

Table 5 (*continued*)
Definition of Waters of the U.S.

Definition Number	Definition
3	All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:
3i	Which are or could be used by interstate or foreign travelers for recreational or other purposes; or
3ii	From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
3iii	Which are used or could be used for industrial purpose by industries in interstate commerce;
4	All impoundments of waters otherwise defined as waters of the U.S. under the definition;
5	Tributaries of waters identified in paragraphs (a)(1)-(4) of this section;
6	The territorial seas;
7	Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs 1-6 of this section; and
8	Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 123.11(m) which also meet the criteria of this definition) are not waters of the U.S.

In January 2001, a U.S. Supreme Court decision in “Solid Waste Agency of Northern Cook County (SWANCC) v. USACE,” changed the direction of the federal regulation of isolated wetlands under the CWA. Previously, the USACE assumed jurisdiction over isolated waters of the U.S. based on its 1986 preamble stating that migratory birds used these habitats. The “Migratory Bird Rule” provided the nexus to interstate commerce and thus protection under the CWA.

The USACE has established guidance for determining between isolated and adjacent wetlands. Wetlands that border, are contiguous with, or neighbor another water of the U.S. (specifically one that flows into navigable water) are considered adjacent. Additionally, wetlands that are within the 100-yr floodplain of another water of the U.S. are also considered adjacent. All other wetlands would be considered isolated and not jurisdictional under the CWA.

Typically, water-filled borrow areas are not considered waters of the U.S. as stated in the preamble of 33 CFR 328.3; however, this preamble does specifically identify that, once a waterfilled borrow area is abandoned and is naturalized it becomes jurisdictional if it meets the definition of waters of the U.S. The following is from the preamble of 33 CFR 328.3 published on November 13, 1986:

> *Waterfilled depressions created in dry land incidental to construction activity and pits excavated in dry land for the purpose of obtaining fill, sand, or gravel unless and until the construction or excavation operation is abandoned and the resulting body of water meets the definition of Waters of the U.S. (33 CFR 328.3(a)).*

Based on the information above, wetlands (totaling 0.5592 ac) and waters (totaling 1,448.36 linear ft) meet the definition of waters of the U.S. in the project corridor. Topographic maps, NWI maps, FEMA FIRM maps, and CIR aerial photography, supported by an on-site visit, were all utilized to make this determination. Impacts to waters would be subject to regulation by the USACE under Section 404 of the CWA.

If there is fill greater than 0.1 (but less than 0.5) ac within an individual water (or wetland), the project proponent must notify the USACE under General Condition 13. Under this notification, the USACE will evaluate all waters to verify compliance but will only require compensatory mitigation for the waters that resulted in the notification. In the event that a single crossing would result in greater than 0.5 ac of fill to a jurisdictional water or wetland, the project proponent would have to submit an individual permit application to the USACE. With this application, the USACE will evaluate the entire project and require compensatory mitigation for all fill to all jurisdictional wetlands and waters. As part of the Section 404 permit process, the permitee must demonstrate the avoidance and minimization strategies that were considered and designed into the project.

The potential wetland areas could still require consideration under EO 11990, even if they are non-jurisdictional wetlands under USACE regulations. The purpose of EO 11990 is to "minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands". To meet these objectives, the EO requires federal agencies, in planning their actions, to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided. Consideration should be given to the requirements of EO 11990 if construction is planned in the vicinity of these wetlands.

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Appendix D

Cultural Resources Survey for the Relocation of Growdon Gate at Lackland Air Force Base, Bexar County, Texas

CULTURAL RESOURCES SURVEY FOR THE RELOCATION OF GROWDON GATE AT LACKLAND AIR FORCE BASE, BEXAR COUNTY, TEXAS

by
Ben Fullerton

for
Weston Solutions
San Antonio, Texas

TEXAS ANTIQUITIES PERMIT NUMBER 5941

MISCELLANEOUS REPORTS OF INVESTIGATIONS
NUMBER 542

WESTON SOLUTIONS

GEO-MARINE GMI
A Subsidiary of Applied Research Associates, Inc.

October 2011

CULTURAL RESOURCES SURVEY FOR THE RELOCATION OF GROWDON GATE AT LACKLAND AIR FORCE BASE, BEXAR COUNTY, TEXAS

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TEXAS ANTIQUITIES PERMIT NO. 5941

MISCELLANEOUS REPORTS OF INVESTIGATIONS
NUMBER 542

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October 2011

ABSTRACT

An intensive archaeological survey was conducted on three alternative routes for the proposed relocation of Growdon Gate at Lackland Air Force Base (LAFB) in Bexar County, Texas. The Proposed Action would consist of a new 2.05 mi-long roadway relocating the Growdon Gate, the Commercial Vehicle Inspection Area, and Growdon Road east of Leon Creek Flood Zone Property, and Alternatives 1 and 2 would consist of a new 1.34 mi-long access road built across the Leon Creek Flood Zone Property from U.S. Highway 90 to Billy Mitchell Road. The archaeological field investigation involved an intensive archaeological survey with pedestrian walkover and shovel testing. Trenching was not conducted due to extensive subsurface quarrying disturbances within areas of mapped Holocene alluvium. The survey resulted in the excavation of 39 shovel tests and the documentation of 41BX1886, a mid-twentieth-century homestead site, within and adjacent to the right-of-way (ROW) of the Proposed Action. Given the minimal information potential associated with this site and lack of integrity due to extensive razing of the historic structures, site 41BX1886 is recommended as not eligible for inclusion in the National Register of Historic Places or for designation as a State Archaeological Landmark. Aside from 41BX1886, no other cultural materials were recovered. As a result, no further investigations are recommended for the presently defined project area. All materials generated by this project will be permanently curated at the Center for Archaeological Research (CAR) at the University of Texas at San Antonio.

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ACRONYMS

AAF	Army Air Force
AFB	Air Force Base
AETC	Air Education and Training Command
APE	Area of Potential Effect
ATC	Air Training Command
BTS	Basic Training School
CAR	Center for Archaeological Research, University of Texas at San Antonio
CTA	Council of Texas Archeologists
FCR	Fire-cracked rock
GMI	Geo-Marine, Inc.
IDTRC	Indoctrination Division, Air Training Command
KAFB	Kelly Air Force Base
LAFB	Lackland Air Force Base
LMTC	Lackland Military Training Center
MTW	Military Training Wing
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NRHP	National Register of Historic Places
OCS	Officer Candidate School
OTS	Officer Training School
RH&T	Recruit Housing and Training
ROW	Right-of-way
SAASC	San Antonio Air Service Command
SAL	State Archaeological Landmark
SHPO	State Historic Preservation Officer
TARL	Texas Archeological Research Laboratory
THC	Texas Historical Commission
TRW/HO	Training Wing History Office
USAF	United States Air Force

CHAPTER 1
INTRODUCTION

This report presents results of Phase I archaeological investigations by Geo-Marine, Inc. (GMI), conducted on three alternative routes for the proposed relocation of Growdon Gate at Lackland Air Force Base (LAFB) in Bexar County, Texas (Figure 1). These investigations were conducted for Weston Solutions, Inc., under contract with the Air Education and Training Command (AETC) (GMI project # 30401.01.17.02). The purpose of these investigations is to provide the AETC, with data for use in the management of its cultural resources in partial fulfillment of its obligations under Section 106 of the National Historic Preservation Act (NHPA) of 1966 (P.L. 96-515, as amended) and the National Environmental Policy Act (NEPA) of 1969 [42 U.S.C. §§ 4321–4347; P.L. 91–190; 83 Stat. 852.

The proposed project involves the relocation of the main gate (Growdon Gate) at LAFB in San Antonio, Texas. LAFB would consider acquiring land adjacent to the base for the construction of a new road to the relocated gate. Three alignment alternatives are proposed, the Proposed Action would consist of relocating Growdon Gate, the Commercial Vehicle Inspection Area, and Growdon Road east of Leon Creek Flood Zone Property (Figure 2). A new 2.05 mi-long access road would be built east of the Leon Creek Flood Zone Property. According to Alternatives 1 and 2, Growdon Road would originate from the same location as the Proposed Action, but would be built across as opposed to around the Leon Creek Flood Zone Property (see Figure 2). Alternatives 1 and 2 would consist of the same 1.34 mi-long Growdon Road from U.S. Highway 90 to Billy Mitchell Road, but would differ in the locations of the entry gate and inspection point. For example, the entry gate and inspection point for Alternative 1 would be located north of the flood zone, whereas the entry gate and inspection point for Alternative 2 would be located south of the flood zone (see Figure 2). The proposed roadways are approximately 50 feet in width, and the estimated depths of impacts are approximately 1 meter with deeper impacts occurring at creek crossings for the installation of bridge support piers.

The Phase I cultural resources survey and archaeological inventory consisted of pedestrian survey, photodocumentation, and the excavation of 39 shovel tests within the project area of potential effects (APE). Project personnel for the cultural resources survey included Principal Investigator Duane Peter, Project Archaeologist Ben Fullerton, and Field Technician Robert Davis. Fieldwork took place between May 3 and 6, 2011, and was conducted under Texas Antiquities Permit #5941. Since land to be acquired Lackland AFB involves property owned by the City of San Antonio, work was conducted under joint NHPA Section 106/Texas Antiquities Permit review.

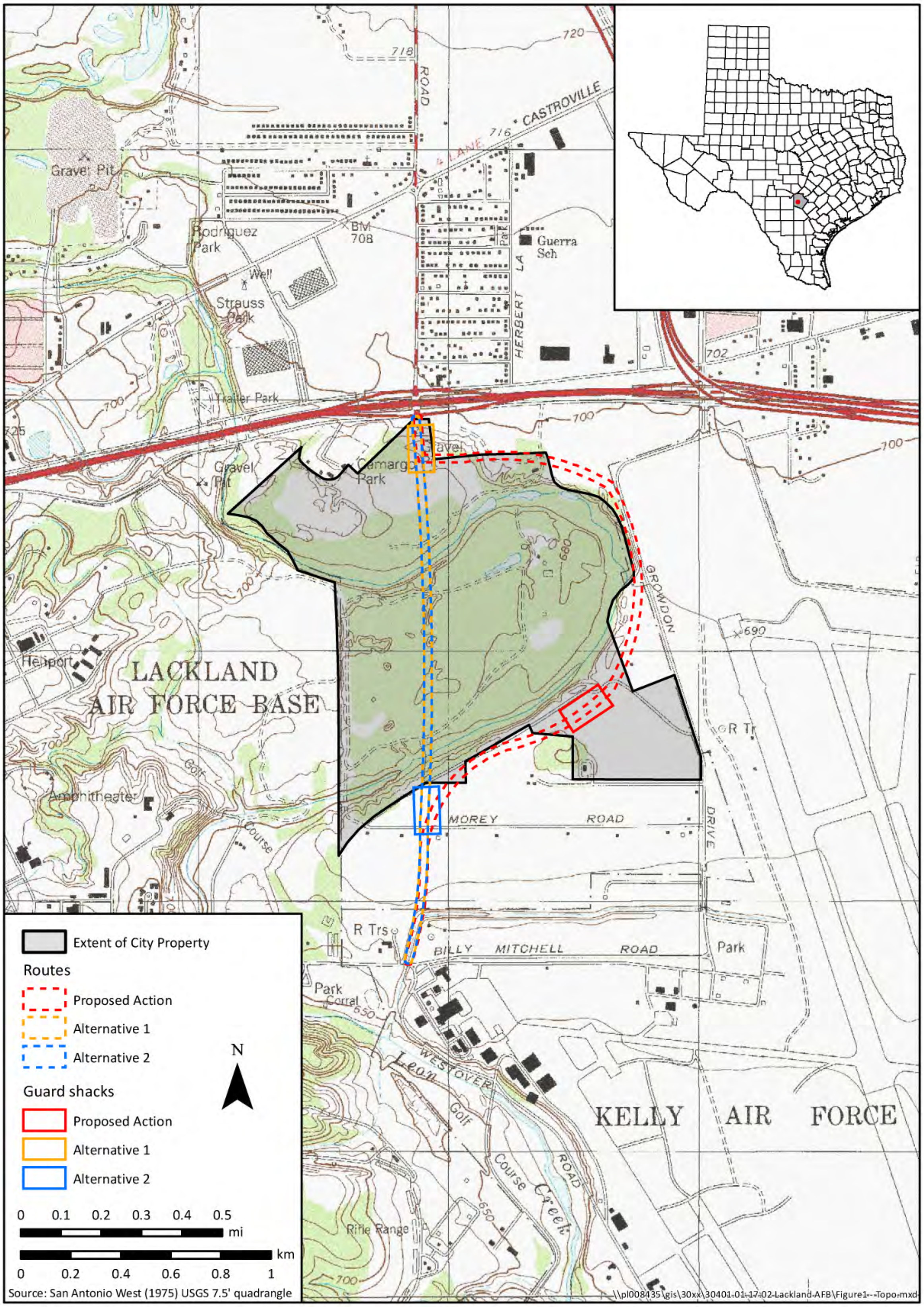

Figure 1. Topographic map showing the extent of city property and proposed road and entry gate route alternatives at Lackland AFB.

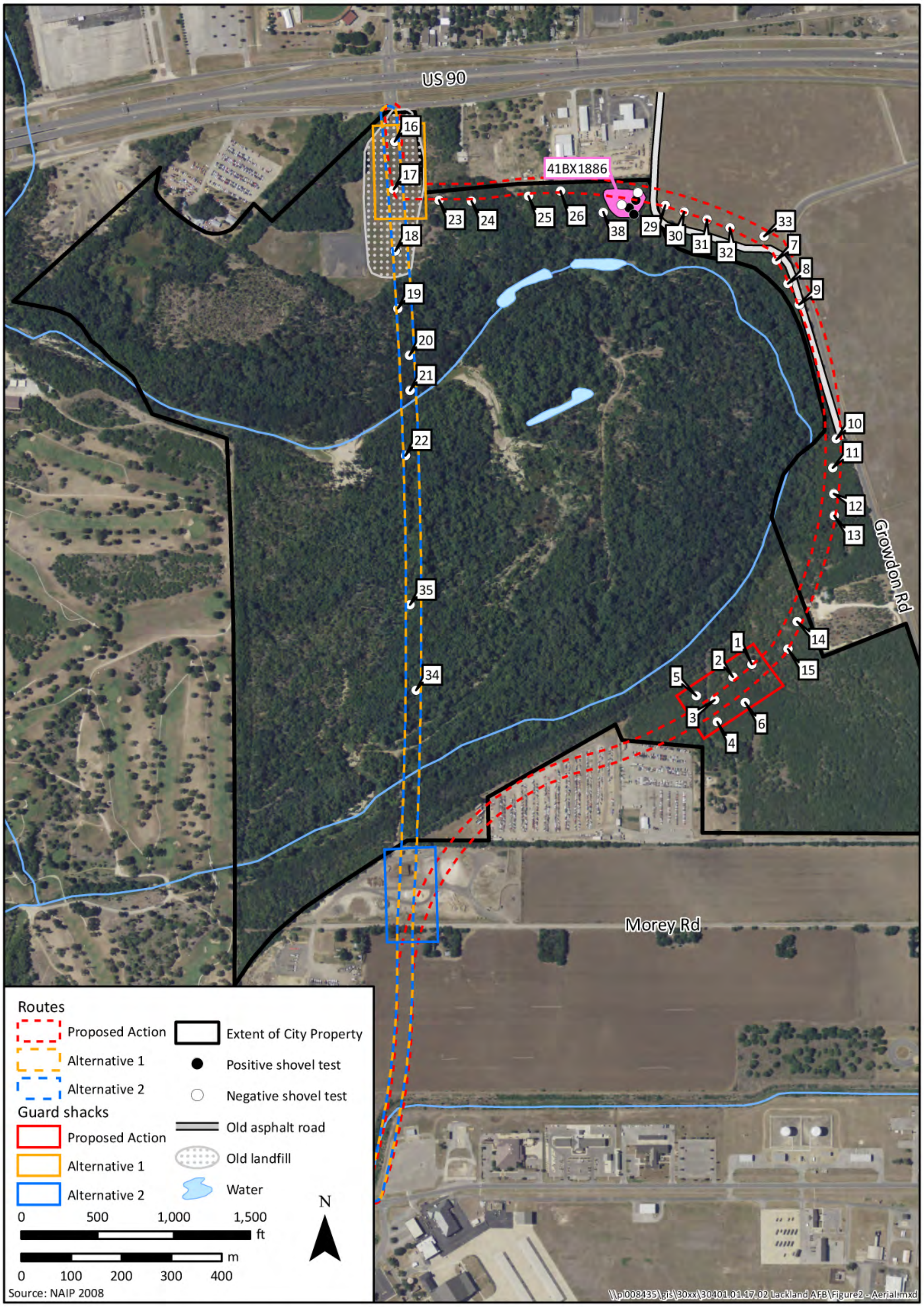

Figure 2. Aerial imagery showing cultural resources investigations at Lackland AFB.

The following sections of this report present the natural setting (Chapter 2), cultural background (Chapter 3), the methods used to carry out the project (Chapter 4), and the results of the Phase I investigation (Chapter 5). Management recommendations derived from the cultural resources investigations are presented in Chapter 6. Following the body of the text is a list of references cited in the report.

CHAPTER 2
ENVIRONMENTAL SETTING

Bexar County includes portions of three physiographic regions: the Edwards Plateau, the Blackland Prairie, and the Rio Grande Plain (also known as the South Texas Coastal Plain). Lackland AFB is situated in the Blackland Prairie (Fenneman 1931; Taylor et al. 1991).

The regional physiography is governed primarily by the Balcones Escarpment, a broad area of faulted limestone forming the southern and eastern edge of the Edwards Plateau. This escarpment rises approximately 304.8 meters (m; l,000 feet [ft]) above the coastal prairie that lies to the south and east. This elevation change has a marked influence on the environmental setting. The escarpment extends from near Del Rio, on the Texas-Mexican border, about 257.5 kilometers (km; l60 miles [mi]) eastward, through northern Bexar County, and on to Austin 112.7 km (70 mi), Temple and Waco to the northeast. This physical feature runs northeast-southwest through the San Antonio area.

In Bexar County, the Edwards Plateau is northwest of the escarpment and is a rugged, hilly, dissected region drained by Cibolo and Balcones creeks and contains the headwaters of Culebra, Leon, and Salado creeks (Taylor et al. 1991:119). Elevations in the Plateau range from 335.4-579.1 m (1,100-1,900 ft). Fenneman (1931) mapped the Edwards Plateau as part of the Great Plains Province.

To the southeast of the escarpment is the slightly undulating Gulf Coastal Plain Province. Along the base of the Escarpment is a region classified as the Blackland Prairie physiographic province, on which Lackland is located (Taylor et al. 1991). The Blackland Prairie is undulating and hilly with elevations ranging from 213.4-304.8 m (700-1,000 ft). It is drained in part by the San Antonio River and in part by tributaries of the Medina River and Cibolo Creek (Taylor et al. 1991:119). Sellards (1919) described this physiographic area as part of the Taylor-Navarro Plain. Much of this plain is covered with gravelly terrace deposits composed of limestone and chert. Some valleys are cut by stream erosion. The Rio Grande Plain is nearly level or undulating prairie, with elevations ranging from 137.2 to 213.4 m (450 to 700 ft). It is drained by the Medina and San Antonio rivers and Cibolo Creek as well as their tributaries (Taylor et al. 1991:119).

GEOLOGY AND SOILS

The bedrock that underlies Lackland AFB is mapped by Barnes (1983) as being Upper Cretaceous undivided Navarro Group and Marlbrook Marl overlain with Pliocene-aged Uvalde gravel and/or Quaternary (Pleistocene and Recent) stream deposits. The Navarro/Marlbrook formation is composed of marl, clay, sandstone, and siltstone, with concretions of siderite and siliceous limestone. The Uvalde gravel, found on hills and ridges, is composed of caliche-cemented boulders of limestones and chert measuring up to one foot in diameter. Well-rounded cobbles of chert, but also smaller proportions of quartz, limestone, and igneous rock, comprise these gravels. The chert cobbles derive from the Edwards Limestone formation of Lower Cretaceous age. Nordt (1997:12-19) recognizes two alluvial terraces in the Medio and Leon Creek valleys. Within the narrow incised flood plain, the T_2 terrace is about 6 m above the modern stream channel and contains undated deposits thought to predate 5,000 B.P. (before present). An episode of down-cutting occurred by 5,000 B.P. and the subsequent deposition created the T_1 terrace, which extends about 2 m above the modern channel and dates 5,000 to 2,000 years ago. Some sediments from the active flood plain (T_0) are inset against and lie atop the T_1 terrace. These sediments date less than 2,000 B.P.

Soils within the project area belong to the Lewisville-Houston Black association and the Venus-Frio-Trinity association. The Lewisville-Houston Black association contains level, deep, calcareous clayey soils developing in old calcareous alluvium. The lowest deposits in this association occur along rivers and streams where soils have washed down from adjacent uplands. The deep, calcareous clay loam of the Venus-Frio-Trinity association is found in the bottomland and low terraces along rivers, major streams, and tributaries. The potential for buried occupational horizons is significantly greater in these soil associations that have formed in alluvial deposits. Five specific soil mapping units were found within the project area (Figure 3):

- Lewisville, silty clay, 0 to 1 percent slopes
- Sunev clay loam, 0 to 1 percent slopes
- Loire clay loam, 0 to 2 percent slopes, occasionally flooded
- Patrick soils, rarely flooded
- Pits and Quarries, 1 to 90 percent slopes

CLIMATE

Bexar County is located on the western edge of the Gulf Coastal Plain resulting in a modified subtropical climate, predominantly continental during the winter months and marine during the summer months (Taylor et al. 1991: 118). The summer is hot, with daily maximum temperatures above 32.2° Celsius (C; 90° Fahrenheit [F]) over 80 percent of the time. Normal mean temperatures range from a low of 16.8° C (62.3° F) in January to a high of 34.6° C (94.2° F) in August. Mild weather prevails during much of the winter months, with below-freezing temperatures occurring on an average of about 20 days each year. Relative humidity averages about 80 percent during the early morning hours most of the year, dropping to near 50 percent in the late afternoon.

San Antonio is situated between a semi-arid area to the west and the humid coastal area with heavy precipitation to the southeast. The average annual rainfall of 70.8 centimeters (cm; 27.89 inches [in]) is sufficient for the normal production of most crops. Precipitation is evenly

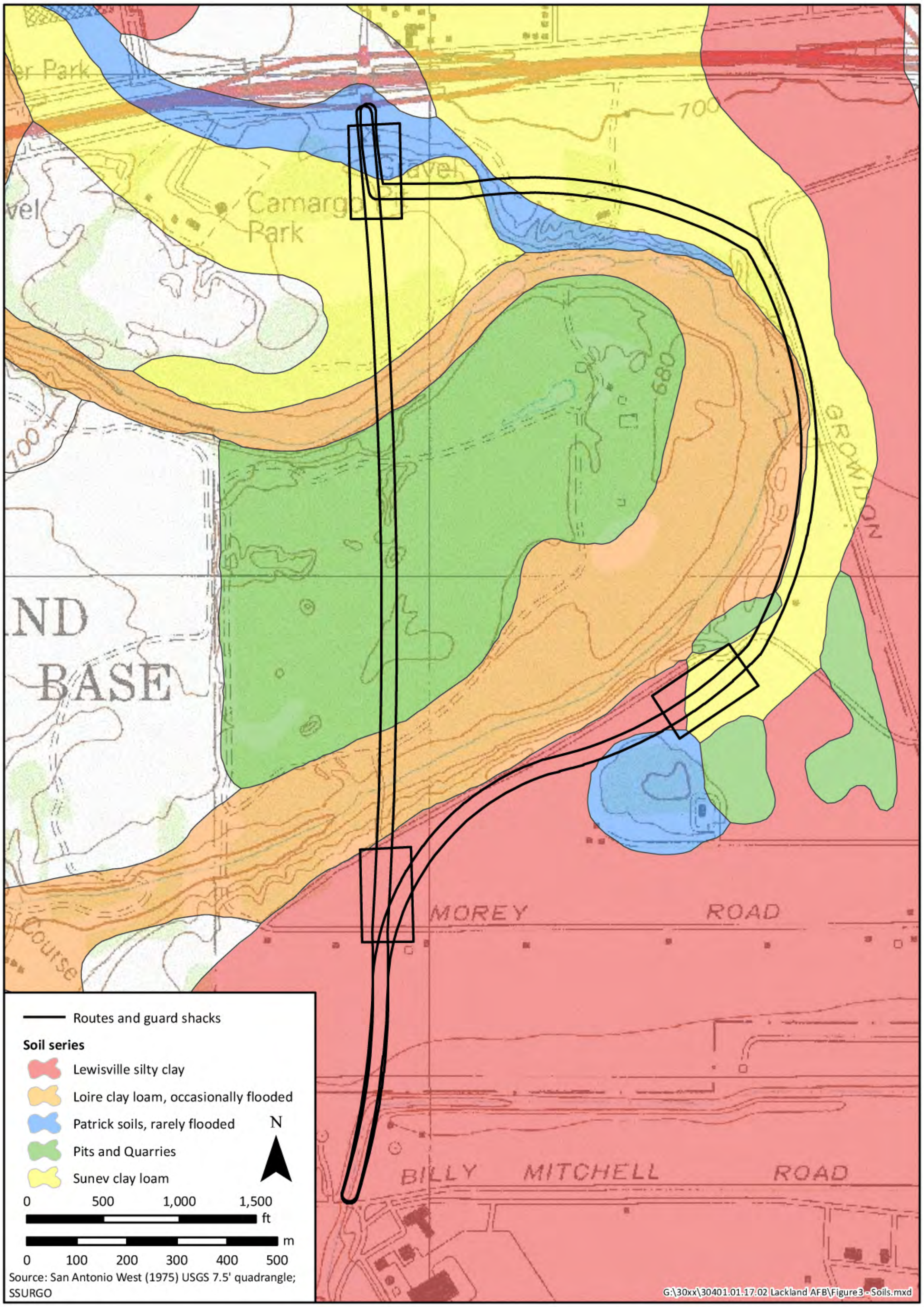

Figure 3. Soil series of the proposed road route and guard shack alternatives at Lackland AFB.

distributed throughout the year, with heaviest amounts falling during May (20.9 cm [8.22 in]) and September (40.0 cm [15.78 in]). Precipitation from April through September usually occurs as thunderstorms that produce large amounts falling in short periods. Most of the winter precipitation occurs as light rain or drizzle. Moisture laden air from the Gulf of Mexico crossing the Balcones Escarpment is orographically lifted, causing periodic severe rainfall intensities. Because of its proximity to the Gulf, storms of a tropical nature also occur, bringing high winds and prolonged rainfall. Thunderstorms and heavy rainfalls have occurred in all months of the year. Hail of damaging intensity seldom occurs, but light hail occurs frequently with the springtime thunderstorms. Measurable snow occurs only once in three or four years.

Northerly winds prevail during most of the winter, while southeasterly winds from the Gulf of Mexico prevail during the summertime and for long periods during the winter near the surface. However, winds in the upper levels (1,000 m [3280.8 ft]) are primarily from the south. Rather strong northerly winds occasionally occur during the winter months with “blue northers”. No tornadoes of any consequence had been recorded in the immediate area until 17 September l988 when an estimated l0 to 12 tornadoes associated with Hurricane Gilbert (a Class 5 hurricane) struck the area.

Though low stratus clouds of orographic origin are common in the evening, these clouds are burned off by the sun during the daytime hours. San Antonio receives about 50 percent of the possible sunshine in the winter and over 70 percent in the summer months. Skies are clear about 35 percent of the time, cloudy about 30 percent and partly cloudy about 35 percent of the time. Average annual evaporation for the period 1907-1930 was 174.2 cm (68.60 in), or almost two and a half times the annual precipitation (Dougherty 1975).

FLORA AND FAUNA

Bexar County is situated at the ecotonal transition between three biotic regions. Therefore, the plants and animals are a mixture of three zones: the Balconian (associated with the Edwards Plateau), the Texan (associated with the Blackland Prairie), and the Tamaulipan (associated with the South Texas Coastal Plain). The flora and fauna of each region is represented to varying degrees in the San Antonio area (Blair 1950).

The land that is now Lackland AFB was originally part of the Blackland Prairie Biome, although some South Texas Plains and Edwards Plateau biota may find their way into the area. Because of this ecotonal setting, the original vegetation was likely quite diverse and abundant. Texas wintergrass (*Stipa leucotricha*), Texas grama (*Bouteloua rigidiseta*), and panic grass (*Panicum* sp.) are considered the dominant climax species, while other grasses such as big bluestem (*Andropogon gerardi*), Indian grass (*Sorghastrum avenaceum*), switchgrass (*Panicum virgatum*), and side-oats grama (*Bouteloua curtipendula*) also would be found. In addition to the grasses are a wide variety of wildflowers including Indian blanket (*Gaillardia pulchella*), upright prairie coneflower (*Ratibida columnaris*), coreopsis (*Coreopsis* sp.) and Drummond skullcup (*Scutellaria drummondii*). Along the waterways, such as Leon Creek, were woodlands consisting of cedar elm (*Ulmus crassifolia*), live oak (*Quercus virginiana*), netleaf hackberry (*Celtis reticulata*), eastern cottonwood (*Populus deltoides*), and pecan (*Carya illinoinensis*). In addition, Black willow (*Salix nigra*), boxelder (*Acer negundo*), and American sycamore (*Plantanus occidentalis*) are associated with live oak and pecan along Leon Creek. Dominant vegetation found on the uplands of the Annex lands includes mesquite (*Prosopis glandulosa*) and huisache.

The original prairie supported herds of bison (*Bison bison*), antelope (*Antilocapra Americana*), deer (*Odocoileus virginianus*), peccary (*Pecari angulatus*), and numerous game birds. The urbanization of the area has caused most of the larger and more sensitive animals to vacate. The present fauna can be divided into two regimes: those inhabiting the urbanized portion and those inhabiting the Leon and Medio Creek bottomlands. Urban tolerant animal and bird species include fox squirrels (*Sciurus niger*), English sparrows (*Spizella sp.*), rusty blackbirds (*Euphagus carolinas*), grackles (*Quiscalus mexicanus*), mockingbirds (*Mimus polyglottos*), robins (*Turdus migratorius*), and chickadees (*Poecile sp.*). The bottomlands of Leon and Medio Creeks form a more protected habitat for wilder species. Beaver (*Castor canadensis*), armadillo (*Dasypus novemcinctus*), skunks (*Mephitis mephitis*), cottontail rabbits (*Sylvilagus sp.*), and opossums (*Didelphis virginiana*) inhabit the bottomlands. The number of bird species that visit bottomlands of Bexar County also may be high. Black bullheads (*Ictalurus melas*), mosquitofish (*Gambusia affinis*), sailfin molly (*Poecillia latipinna*), warmouth (*Lepomis gulosus*), bluegill (*Lepomis* macrochirus), largemouth bass (Micropterus salmoides), Rio Grande perch (Cichlasoma cyanoguttatum) as well as introduced species of mouthbrooders may inhabit the Leon Creek wetlands. Also occurring are a large number of frogs, toads, salamanders and such reptiles as lizards and snakes.

PALEO-ENVIRONMENT

The environmental conditions presently found in Bexar County and Lackland AFB represent relatively recent conditions arising from climatic oscillations and reaction to the historic introduction of domesticated animals by the Hispanic people during the past 300 years. Current studies indicate that in prehistoric times spanning the past 12,000 years of human existence, the region experienced changes in the environmental conditions. Reconstruction of these past conditions is of interest to archaeologists, since those conditions provide a context for interpreting environmental constraints that affected decisions the ancient people made about subsistence patterns and technological innovations used to convert natural materials into usable aspects of their culture.

Detailed reconstruction of past environments is not possible, but there are many lines of evidence, called proxies, that are useful in reconstructing these past conditions. Such proxies can be grouped into three general classes comprised of geological, floral and faunal remains. The geological proxies include delineation of periods of stream valley filling, stability and erosion; the mass erosion of upland deposits; rates of sedimentation; and carbon isotope studies of soils. The floral proxies are derived from preserved macrobotanical studies of plant parts (seeds and wood identifications, and cell growth structure variability in wood, etc.), and microbotanical plant parts (pollen and phytolith identifications, etc.). The faunal proxies are derived from the identification of animal bones, terrestrial and aquatic snails, insects, and ostracodes, and deriving inferences about their preferred habitat conditions. A critical component to reconstructing past environments is the absolute dating of the proxy event, and the recognition that some lines of evidence respond more rapidly to changes in the environment than other lines of evidence (Caren 1998). The scale of investigations is also difficult to control, since sometimes, isolated habitats persist in special niches when changes are occurring all around. Thus, different kinds of proxies are apt to provide various degrees of resolution. For these reasons, the reconstruction of the paleoenvironmental conditions sometimes seems to be contradictory. The precision in defining the magnitude wet-dry, and warm-cool cycles is generalized, at best. Nevertheless, there seems to be general regional trends discernable. Much of the following is derived from syntheses developed by Decker et al. (2000), Collins (1995); Ellis et al. (1995); Johnson and Goode (1994).

Late Pleistocene

The last glacial advance in North America began to wane approximately 25,000 years ago. Although the ice sheets never extended farther south than the area of South Dakota, the environmental conditions were generally regarded as being much cooler and wetter than at present (Bryant and Holloway 1985). Even though there was no glacial melts near south Texas, there was quite likely considerable erosion of the various riverbeds through the region, including the Colorado and Pedernales with subsequent aggrading channels filled with coarse gravels and cobbles prior to 13,000 years ago (Blum 1989, 1992; Blum and Lintz 1993; Blum and Valastro 1992). Comparable creek scouring and gravel accumulations are apt to have occurred in the Medio and Leon Creeks at Lackland (Nordt 1997).

Pollen records from south Texas suggests that prior to 14,000 years ago, parklands and scrub grasslands was present on the southern High Plains, pinyon-juniper woodlands were extant in the Trans-Pecos region and spruce-fir woodlands existed in central Texas (Bryant and Holloway 1985). Over the next few thousand years, pollen and isotope studies suggest that these plant communities began to be replaced by various grass and shrub species and a marked decline in spruce that was thought to signal slightly warmer and drier conditions (Bousman 1992, 1994).

Studies of beetle parts preserved in pond sediments of north Texas indicate that between 14,000 and 13,000 years ago, temperatures may have been as much as 10^{o} C cooler than present, and small mammal remains from Hall's Cave in Kerr County indicate that the climate was about 6^{o} C cooler (Elias 1994; Toomey et al. 1993). Against these lines of evidence for cooler environments is the data on variation in carbon isotope ratios recovered from soils of the Applewhite Reservoir project, along the Medina River south of San Antonio. Here, Nordt et al. (1994) found evidence for the relative increase in C_4 (warm grasses) in deposits dating between 14,000 to 13,000 and again in deposits dating between 11,000 and 10,000 B.P. The latter event is sometimes referred to as the "Clovis drought" (Haynes 1991). It is presently difficult to interpret the magnitude of these changes, but the data does reflect that there was the beginning of a relative warming trend that began during the terminal Pleistocene. It is likely that at some brief point during the period 10,000 to 9,000 B.P. the cool-moist climate of the Pleistocene briefly passed though an episode of modern conditions. For after ca. 9,000 B.P. environmental proxies indicate that the region was warmer and drier than at present.

The end of the Pleistocene saw the extinction of many forms of mammals from the region. Mammoths, mastodons, camels, horses, and mega-sized bison all became extinct as a result of the climatic change towards drought. Considerable literature suggests that human preying on these megafauna species contributed substantially to the passing of these animals. And although clear associations exist between humans and megafauna during this period, archaeologists still debate whether humans were slaying these animals or taking opportunistic advantage of some hunting situations. Systematic screening of Paleo-Indian deposits has documented that most groups actually utilized a diversified range of resources, including the consumption of rodents, small mammals and reptiles.

Early-Middle Holocene Climatic Conditions

The paleoenvironmental record for the period from 9,000 to perhaps 4,500 B.P. reflects a prolonged xeric episode that was much warmer and drier than at present (Collins 1995:377). This period is variously called the altithermal or hypsithermal interval and is characterized as being global in extent (Antevs 1955a, 1955b; Deevey and Flint 1957). Evidence from the faunal assemblage at Hall's cave, as well as glacial data from the southern Rocky Mountains indicate that there was a period of amelioration in the severity of the warm-dry conditions, suggesting that the period should be conceived as having a two-stage expression (Benedict 1975, 1979; Toomey 1993).

Geomorphic studies of the Colorado, Brazos and Trinity rivers indicate that the Pleistocene terraces were eroded by about 9,000 B.P. and that new terraces were under construction during most of this Early to Middle Holocene record and are truncated by erosion by about 5,000 years ago (Blum 1989; Collins 1995:Table 2; Ferring 1990; Nordt 1993). In north central Texas, the Sanger alluvium along the Trinity River (10,946 to 5,600 B.P.) is roughly coeval with the Fort Hood alluvium along the Leon River tributary of the Brazos River (8,000 to 4,800 B.P.) (Ferring 1990; Nordt 1992). These in turn are comparable to the "Early-Middle Holocene terrace" of the Colorado River (9,000 to 5,000 B.P.) and the 2B/3e horizons (ca. 10,000 to 4,900 B.P.) at Lubbock Lake (Blum 1989; Blum and Valastro 1992; Johnson 1987).

This second period of entrenchment and terrace construction around 4,500 to 5,000 B.P. coincides with the later period of the second severe drought (Collins 1995:Table 2). Although the precise timing of the erosion may not be entirely synchronous, it seems that some differences relate to the distances of the study areas from the mouths of the rivers. It is probable that a regional climatic cause underlies the initiation of erosion in these diverse river valleys. Similarly, the rate of sedimentation entering sinkholes and caves in the uplands around Kerr County during the early Holocene suggests that the paucity of vegetation cover did little to retard surface erosion from upland settings and mass down wasting or extensive upland erosion occurred during the interval 8,000 to 5,000 B.P. (Toomey 1993:457; Toomey et al 1993). The rate of surface deflation suggests that vegetation in Kerr County may have been sparse scrub, rather than constant grass cover.

Studies from Hall's Cave also note that between 5,000 and 2,000 B.P. grooved-tooth pocket gophers were replaced by smooth-tooth pocket gophers and yellow-faced pocket gophers; these latter two species tend to inhabit shallower sediments composed of clayier and rockier sediments than those favored by the grooved-toothed gophers (Toomey 1993:459).

The pollen record from places like Boriak and Weakly bogs east of the Balcones escarpment reveal vegetation cover shifting from woodland at 9,000 B.P. to predominately grassland savannas with a brief interval of woodlands between 8750 and 7500 B.P. (Bousman 1994). Phytolith studies along Coleto Creek indicate that the aridity lasted until some 4,500 years ago as expressed by the presence of grasslands (Robinson 1979). Other studies indicate that xeric conditions lasted until ca. 3,500 years ago. All lines of evidence taken together indicate that the two-interval hypsithermal was a period far more arid than at present.

Late Holocene Climatic Conditions

The Late Holocene record is a period of climatic fluctuations. Most studies generally suggest that more mesic conditions prevailed between 3,500 and 1,000 years B.P. During this period, most rivers in central Texas continue terrace construction unabated, although perhaps at a somewhat slower rate than the previous period. These new terraces include the Pilot Point alluvium in the upper Trinity River, the West Range Alluvium at Fort Hood, and the "Late Holocene Terrace" in the Colorado River.

Furthermore, the sedimentation rates in Bering Sinkhole and Hall's Cave suggest a slowing of erosion, but Toomey (1993:460) thinks that it may be due to the higher incidence of stony materials in the upland sediments. A number of distinct soils developed towards the end of this period. These include the Caddo County paleosol of the southern High and Rolling Plains and the West Fork Paleosol of the Trinity River (Ferring 1990; Hall and Lintz 1984).

With increasing moisture a vegetation succession began, starting with grassland savannas as represented by phytoliths and pollen (Robinson 1979). The luxuriant growth of grass led to the expansion of bison and herds thrived across central Texas during the period 4,500 to 2,000 B.P. (Dillehay 1974). A marked decrease in bison is generally noted in archaeological sites dating from 2,000 to 1,000 B.P. that may coincide with the establishment of non-grassy vegetation cover due to elevated moisture stimulating plant succession of species not favored by bison. In the Texas panhandle, the recovery of remains of prairie voles in deposits dating between 2,000 and 1,000 B.P. provides further evidence of increased moisture.

However, by ca 1,000 to 800 B.P., there is substantial evidence of a rather abrupt return to xeric conditions across Texas that lasted for about 300 to 500 years. The geomorphic record reflects the termination of terrace development in many rivers and repetitive deep erosion is noted in many streams of the Trinity, Brazos, Colorado, and Medina rivers. Herds of bison and antelope are now common across central Texas, as a further indication of warm and drier conditions (Dillehay 1974). Phytolith studies from Choke Canyon Reservoir in South Texas and pollen studies from regional bogs document the presence of plants signaling the return of xeric conditions (Bousman 1994; Robinson 1979). All lines of evidence indicate that the droughts of the twelfth century A.D. never matched the intensity of the conditions of the hypsithermal.

By ca. 500 years ago, the climate became more mesic, but the weather became cooler than at present. Historic records in Europe record this interval as the Neo-Boreal or "Little Ice Age" (Bryson and Paddoch 1980). Winters were so severe across North America and Europe that portions of the Great Lakes and many rivers froze. Such hard freezes were not as severe in south central Texas. Evidence from Texas of the return to mesic conditions is reflected in the oxygen isotope results obtained from mussel shells from north Texas (Brown 1998), and the expansion of woodlands in north central Texas. Many of the stream valleys started one final period of terrace construction. These sediments are variously designated the "unnamed recent" alluvium along the Trinity and Colorado rivers, the Ford alluvium at Fort Hood, and Stratum 5A at the Lubbock Lake site (Blum and Valastro 1992; Ferring 1990; Johnson 1987; Nordt 1993). The development of modern climatic conditions has only occurred only in the past 150 years. Probably one of the biggest changes to the environmental conditions—especially the biotic community composition stems from the introduction of sheep, cattle and horses to Texas during the past 300 years. The intensive grazing on native vegetation has effectively converted many of the grasslands found in southern Texas to barren, cactus-infested lands that have been largely stripped of ground cover and sediment (Weniger 1984).

CHAPTER 3
CULTURAL BACKGROUND

PREVIOUS ARCHAEOLOGICAL INVESTIGATIONS

Personnel from GMI conducted a records search of archaeological sites, cultural resources surveys, and maps to identify previously recorded cultural resources surveys and previously recorded archaeological sites within 1.6 km (1.0 mi) of the project area. The results of this research are presented below. Numerous surveys have been conducted within 1.6 km (1.0 mi) of the project area; however, only several encountered archaeological sites. These investigations are discussed below. No archaeological sites have been recorded within the presently defined project area.

Six archaeological sites have been previously recorded within 1 mile of the project area: 41BX958, 41BX1061, 41BX1065, 41BX1066, 41BX1107, and 41BX1108.

Site 41BX958 was recorded by GMI in 1991 during a survey for Kelly Air Force Base (KAFB). The site represents a twentieth century historic site found on an upland surface along the boundary fence of KAFB. According to historic topographic maps, the structure encountered during the survey was constructed sometime between 1922 and 1938. The site was recommended ineligible for inclusion in the National Register of Historic Places (NRHP).

In 1997, a large-scale survey of Lackland AFB and the Lackland Training Annex was undertaken by the Center for Archaeological Research (CAR) at the University of Texas at San Antonio (Nickels et al. 1997). The survey included the investigation of 41BX1061 at the Wherry Housing area (Raymond 1997) and the intensive shovel testing of four “Special Areas” designed for development that included sites 41BX1065 and 41BX1066 (Durst 1997). Site 41BX1061 represents a historic sewer line installed in the early 1900s when the base was first acquired. Site 41BX1065 represents a Middle Archaic through Transitional Archaic campsite found within the upper 55 cmbs at the edge of a large, flat terrace overlooking Leon Creek. Fifty shovel tests, 7 1-x-1-m test units, 7 Gradall trenches, and 2 backhoe trenches were excavated at the site. The test units encountered sterile deposits at depths ranging from 35 to 62 cmbs. The site was considered to have moderate to high research potential, but no further work was recommended. It is unclear if a proposed housing expansion eventually impacted the site. Site 41BX1066 consisted of a small lithic surface scatter found on top of a flat knoll overlooking Leon Creek. Debitage and expedient tools comprise the assemblage recovered from the site; however, no diagnostic materials or features were found.

Site 41BX1107 represents an Early to Transitional Archaic lithic quarry site found by CAR (Nickels et al. 1997). The site was found in an eroding surficial context on a slight slope above Medio Creek near the 4th green on the Lackland AFB golf course. Artifacts consisted of interior flakes, thinning flakes, retouched flakes, and an Edgewood point. FCR was also found on the surface adjacent to the lithic scatter; however, no intact features were found. Site 41BX1108 represents an unknown prehistoric campsite found on the interior of a large meander of Leon Creek (Nickels et al. 1997). The artifacts were exposed on the surface and included thinning flakes, FCR, mollusk shell, bone, and debitage. In addition, a presumed burned rock midden of unknown age was identified. Although impacts from construction and maintenance of the golf course were observed, future subsurface testing was recommended for both sites.

In 2006, GMI conducted archaeological eligibility testing on several sites located along Leon Creek: 41BX1061, 41BX1107, and 41BX1108 (Huhnke 2006).

Nine shovel tests placed at 10-m intervals were excavated at 41BX1107. A total of 32 artifacts was recovered including debitage, a core, and a utilized flake; however, no FCR was recovered. The vast majority of the artifacts were recovered from the upper 20 cmbs, although some were recovered between 20 and 50 cmbs. The investigation determined that the sediments containing the artifacts had been mixed with sand fill and were in secondary context. The site was recommended ineligible for inclusion on the NRHP.

Seven shovel tests were excavated along two transects at 41BX1108. Numerous flakes were noted in the upper 60 cmbs and an Early Archaic Guadalupe biface was found between 10 and 20 cmbs. Nearly 200 lithic artifacts were recovered during testing. A shovel test also encountered a large burned rock feature between 45 and 60 cmbs. It was suggested by the large size of the cobbles that the cobbles were related to food cooking and not refuse from boiling activities. The investigations concluded that artifacts at the site may have accumulated on a stable surface. In sum, the site was determined to have good integrity, intact features, multiple stratified artifact zones, and preservation of bone and shell. The site was recommended as eligible for inclusion in the NRHP.

Finally, eligibility testing was also attempted on 41BX1061, a historic sewer line built in the early 1900's. Unfortunately, the open features at the site were determined to be a safety hazard and were filled in before additional testing could be conducted. However, as it was determined that the features at the site were not part of an early historic homestead and considering the lack of integrity of the sewer system, the site was recommended as ineligible for inclusion in the NRHP.

CHRONOLOGICAL FRAMEWORK

Lackland AFB is located within the Central Texas archaeological region as defined by various archaeologists (Brown et al. 1982; Prewitt 1981; Suhm 1960; Suhm et al. 1954). Cultural periods associated with this area include Paleo-Indian, Archaic, Late Prehistoric (Prewitt [1981, 1985]), Protohistoric, and Historic, based on chronologies developed by Johnson and Goode (1994), Johnson (1995), and Collins (1995). Several phases or complexes are attributed by various authors to each period for Central Texas, but there is considerable debate about the significance of reality of the various phases.

Cultural Periods

Paleo-Indian Period (11,500-8,800 B.P.)

The Paleo-Indian period is the earliest substantiated cultural period in Texas, evidenced across Central Texas by sites and isolated artifacts. Often characterized by small but highly mobile bands of foragers that were specialized hunters of Pleistocene megafauna, recent investigations indicate that these people actually utilized a wider array of resources. Subsistence in this period included large herbivores such as mammoth, bison, and horse but was probably based more consistently on smaller animals such as turtles, land tortoises, alligator, mice, badger, and raccoon (Collins et al. 1989; Story 1990) and presumably also included an array of plants (Collins 1998).

The period can be divided into two temporal divisions, or early and late subperiods. The Early Paleo-Indian subperiod consists of two temporally distinct cultural assemblages using predominantly different fluted projectile point styles: Clovis and Folsom. Clovis assemblages include the diagnostic fluted lanceolate Clovis point, along with engraved stones, bone and ivory points, stone bolas, and ochre (Collins 1995; Collins et al. 1992). Clovis component sites reported in Central Texas include Kincaid Rockshelter (41UV2), Wilson-Leonard (41WM235), Gault (41WM9), Horn Shelter No. 2 (41BQ46), and Pavo Real (41BX52). Surface finds of distinctive Clovis points are reported from a number of other localities (Meltzer and Bever 1995). Folsom tool kits consisted of fluted Folsom points, thin unfluted (Midland) points, large thin bifaces, and end scrapers that were more conducive to specialized hunting, particularly bison (Collins 1995:382). Folsom components have been identified at St. Mary's Hall (41BX229), Horn Shelter No. 2, Pavo Real and Kincaid Rockshelter sites.

Spanning the end of the early and beginning of the late Paleo-Indian subperiods are several projectile point styles, including the Plainview, Dalton, and San Patrice points, for which the temporal, technological, or cultural significance is unclear. The late subperiod is also characterized by the Wilson, Golondrina-Barber, and St. Mary's Hall point styles (Collins 1995). Climate was trending toward more moderate conditions, and the larger fauna from the previous period are no longer available. Most of the associated fauna from this subperiod are smaller animals and deer. The characteristics of the Wilson, Golondrina-Barber, and St. Mary's Hall components are more Archaic-like in that there are burned rock features, though the features contain less rock and the features are much smaller than in later times.

In contrast to the earlier remains, these Late Paleo-Indian points are associated with extinct (bison occidentalis) and modern bison (*Bison bison*) and often occur as surface finds throughout Central Texas. Horn Shelter No. 2 (41BQ46 [Forrester 1985]), located on the Brazos River in Bosque County, Hinds Cave (41VV456 [Shafer and Bryant 1977]) in Val Verde County, and Wilson-Leonard (41WM235 [Collins 1998]) in Williamson County have yielded subsistence data indicating that a variety of vertebrate fauna was being consumed by the Late Paleo-Indian peoples.

Archaic Period (8,800-1,200 B.P.)

Toward the end of the Late Paleo-Indian period a great variety of projectile point styles began to appear. The subsequent Archaic period (8,800-1,200 B.P.) is broadly characterized by stemmed and side-notched dart points and by the appearance of ground and pecked stone tools. The subsistence pattern may have become more diffuse, reflective of a greater exploitation of local environments, with exclusively smaller animals, especially smaller game animals, fish, and wild plant foods increasing in dietary importance. Like their predecessors, Archaic peoples apparently continued to follow a nomadic way of life, traveling seasonally to utilize different food resources in various localities (cf. Weir 1976). In northern and central Bexar County, major occupation sites are situated on stream terraces. These sites generally consist of a series of burned rock middens that are frequently buried. Technologically varied quantities of lithic debris and a wide variety of projectile points suggest that the sites were revisited over several thousands of years (McGraw and Hindes 1987:47). The Archaic period is generally divided into early, middle, and late subperiods (Black 1989; Collins 1995; Story 1985). Each subperiod includes several temporal-stylistic intervals based on diagnostic projectile point styles and associated radiocarbon assays (Collins 1995).

Early Archaic (8,800-6,000 B.P.) sites are small and tool assemblages are very diverse (Weir 1976:115-122), suggesting that populations were highly mobile and densities low (Prewitt 1985:217). Paleoclimatic conditions of the Early Archaic are usually regarded as warmer and drier than at present. Concentrations of Early Archaic sites along the southern and eastern margins of the Edwards Plateau may indicate that the area had more reliable water sources and a diverse subsistence base. The margins of the Edwards Plateau are ecotonal in character and may have provided reliable resources during times of environmental stress (Story 1985:31, 34).

Early Archaic sites, such as Loeve-Fox (41WM230), Wilson-Leonard (41WM235), Richard Beene (41BX831), Sleeper (41BC65), Jetta Court (41TV151), Youngsport (41BL78), Camp Pearl Wheat (41KR243), and Landslide (41BL85) are usually described as open campsites or lithic procurement stations. Kincaid Rockshelter (41UV2) is one of only a few rockshelters that occur in the Edwards Plateau during this period. Lithic procurement site location is determined by the natural distribution of cherts. Large and varied burned-rock features (Sleeper, Camp Pearl Wheat, Wilson-Leonard, Richard Beene), domestic structures (Turkey Bend Ranch [41CC112]), and caches (Lindner) are also known in the Early Archaic (Collins 1998:64). Three recognized point styles (Angostura; Early Split Stem [Gower and Jetta]; and Martindale-Uvalde) indicate that the makers tended to occupy the better-watered eastern part of the Edwards Plateau (Collins 1998:65). Assemblages also include Clear Fork and Guadalupe bifaces, manos, metates, hammerstones, burins, circular scrapers, and a variety of bifaces. Few burials have been assigned to this period (Prewitt 1981:77-79; Story 1985:34-35), and settlement/subsistence systems are hypothesized to have been diffuse, utilizing a variety of resources and frequently shifting the loci of subsistence activities rather than intensifying the use of any specified resource (Story 1985:39).

The Middle Archaic (6,000-4,000 B.P.) exhibits more numerous and more varied sites than the preceding Early Archaic. This cultural manifestation is thought to be characterized by a population increase, the development of regionally distinct cultural patterns, and changes in settlement patterns, economic and social systems, and technology (Prewitt 1985). In addition, territorial boundaries may have begun to emerge (Story 1985:39). The paleoenvironmental conditions have ameliorated considerably.

Middle Archaic sites are represented by rockshelters, campsites, lithic quarries, and kill sites (Weir 1976). The burned rock middens that first appeared toward the end of the Early Archaic became very widespread in Central Texas during the Middle Archaic. Black et al. (1997:9) posit that burned rock oven middens indicate a reliance on semisucculants, such as yucca hearts, sotol and agave; other utilized plants include prickly pear and the bulbs of members of the onion or lily family. Prewitt (1985:222-226) also notes that the abundance of rock middens indicates hot rock oven cooking of a greater reliance on plant foods, mostly bulbs and tubers, although tool kits still reflect a strong reliance on hunting. Black et al. (1997:7-8) recognize a variety in burned rock oven features that reflect geographical distribution. These forms range from the domed, Weir Type I (Weir 1976) midden found on the eastern Edwards Plateau to the ring-shaped burned rock midden possessing a central depression found as far west as the Lower Pecos region. Data concerning mortuary practices are not available except for the end of the Middle Archaic, during which time cremations have been reported (Prewitt 1981:81). Three point styles are diagnostic of this subperiod: Bell-Andice-Calf Creek, Taylor, and Nolan-Travis. Bifaces, a variety of scrapers, unifaces, and grinding stones are also present. Prewitt (1981:73) suggests that the proportion of projectile points compared to total number of tools (50 percent) is indicative of a balance between the exploitation of plant and animal resources.

The Late Archaic subperiod (4,000-1,200 B.P.) is characterized by the emergence of new cultural patterns as well as the intensification of pre-existing ones (Story 1985:45). Coastal marine shells, used either as ornaments or as raw materials for ornaments, were exchanged with inland groups, at least on a limited basis, in return for finished lithic tools and/or siliceous raw material (Story 1985:48). Some of these Late Archaic trade networks may have extended east as far as the Florida panhandle (Hall 1981). The use of burned rock middens throughout the Late Archaic appears to have been a major part of the subsistence strategy as a decrease in the importance of hunting, inferred by the low ratio of projectile points in relation to other tools in site assemblages, may have occurred (Prewitt 1981:74). Bison, which had been absent from the area for most of the Archaic, were once again available in the region (Dillehay 1974).

Late Archaic sites include rockshelters, campsites, and large cemeteries. The establishment of these large cemeteries along drainages suggests strong territorial ties by certain groups (Hall 1981; Story 1985:40). In addition to cemeteries (e.g., Orchard [41BX1] and Loma Sandia [41LK28]; Story 1985:49), isolated flexed burials have been recorded for this period (Prewitt 1981:81-82). Features include basin hearths, arcuate hearths, and mussel shell caches. The lithic assemblages contain a variety of dart point styles (e.g., Bulverde, Pedernales-Kinney, Lange-Williams-Marshall, Marcos-Montell-Castroville, Ensor-Frio-Fairland, and Darl); Erath, San Gabriel, and Hare bifaces; gravers; scrapers; a variety of unifaces and bifaces; grinding stones; and boatstones. Other artifacts include ulna flakers, bone beads and awls, stone and marine shell gorgets, and freshwater mussel shell pendants (Prewitt 1981:81-82). The use of burned rock slowed during this period, but did not cease.

Late Prehistoric Period (1,200 to 300 B.P.)

Following the Archaic, the Late Prehistoric period is characterized first by the introduction of the bow-and-arrow and later by ceramics, probably from the north where they appear at least a half millennium earlier. The cultural mechanism(s) for the transmission of these technologies is still unknown (Prewitt 1985:228). The Late Prehistoric in Central Texas is divided into two phases, the Austin and the Toyah (Jelks 1962; Prewitt 1981). The Austin phase (ca. A.D. 800-A.D. 1300) is distinguished by the first appearance of arrow points, specifically, an expanding stem form with deep corner notches, known as Scallorn and Edwards points. Despite the continuity of an "overall subsistence pattern of a mobile, broad-based hunting-gathering tradition" (McGraw and Hindes 1987:48), other changes are apparent. A settlement pattern shift from open habitation sites to rock shelters can be discerned, suggesting that there was a population decline during this phase (Prewitt 1981; 1985:217). In addition, true cemeteries appear to be widespread (e.g., Loeve-Fox; Prewitt 1982). Although the subsistence economy was still heavily dependent on gathering a variety of plant foods, hunting seems to have increased in importance, as indicated by an increased ratio of projectile points to other tools and by an increased frequency of deer bones in midden deposits; but bison are scarce to absent in south Texas during this time (Dillehay 1974; Prewitt 1981:74, 83). The use of burned rock oven middens for plant food processing continued (Black et al. 1997; Goode 1991; Kleinbach et al. 1995:795). Horticulture came into play very late in the region, but was of minor importance to the overall subsistence strategy (Collins 1995:385).

Austin phase sites occur on terraces and in rockshelters. In addition to Scallorn-Edwards points, the artifact assemblage includes Friday bifaces, scrapers, unifaces, grinding stones, painted stones, ulna flakers, bone awls and beads, and marine shell beads and pendants. Basin-shaped hearths are present. A series of circular houses with large central rock hearths have been found at the Graham-Applegate (41LL419) site in Central Texas (http://www.texasbeyondhistory.net/graham/index). The introduction of Scallorn and Edwards points is often marked by evidence of violence and conflict, as many excavated burials contain these point tips in contexts indicating they were the cause of death (Prewitt 1981). Burials, isolated and in cemeteries, consist of noncremated (flexed or semiflexed) and cremated interments usually associated with habitation sites (Prewitt 1981:83).

The subsequent Toyah phase (A.D. 1300-1700) is characterized by contracting stem arrow points (Perdiz), bone-tempered ceramics, small endscrapers, and diamond-shaped, beveled knives (Prewitt 1981:74, 83). The technology and subsistence strategies of this phase represent a completely different tradition from the Austin phase. Burned rock middens fell nearly out of use (Black et al. 1997) since bison were once again available in Central Texas (Collins 1995:388; Dillehay 1974). Hunting, especially of bison, may have attained equal or greater importance than gathering, as reflected by the lithic tool assemblage that seems to have been oriented toward bison procurement and processing (Prewitt 1981:74, 84). However, faunal data from sites such as Panther Springs Creek (41BX228; Black and McGraw 1985) indicate that deer continued to be the most important meat resource at some sites. Cultigens are occasionally recovered from Toyah phase sites and "the occasional presence of corn cobs suggest that either Toyah Phase peoples actively traded with agricultural peoples; or they practiced a mixed hunting, gathering, and nomadic horticultural subsistence pattern" (Prewitt 1981:74).

Toyah phase sites occur on terraces and in rockshelters. In addition to those previously mentioned, the artifact assemblage includes Clifton points, drills, grinding stones, bison bone tools, bone beads and awls, ulna flakers, freshwater mussel shell pendants, and a variety of objects made of perishable materials (e.g., wood, cordage). The presence of Caddoan ceramics is indicative of an extensive trade network. Features consist of large flat hearths, basin-shaped hearths, pits, and burials. As with the Austin phase, both cemeteries and isolated interments occur in the Toyah phase. Although cremations are present, semiflexed burials predominate. Intergroup conflict is suggested by the frequent occurrence of arrow points embedded in the human remains (Prewitt 1981:83-84).

Historic Period (post-A.D. 1519)

The most radical cultural changes in Central Texas occurred during the Historic period, which is characterized by the appearance of and, much later, the domination by Europeans and by the invasions of nonlocal Indian groups, such as the Tonkawa, Lipan Apache, and the Comanche. Although possibly initially contacted by Spaniards in the early 1500s, the culture of the local Indian populations in Central Texas probably did not change very much until the later 1600s when, Spanish Missions were founded in east Texas and pressure from Native American horse nomads forced, local groups to seek protection in Spanish missions. Prior to this time, the changes that occurred were probably adaptations of elements of European material culture by local groups rather than a destruction or abandonment of their own cultures. After 1700, many traditional stone, bone, and wooden items were replaced by European metal, glass, and cloth articles and by guns. Eventually, the traditional cultures of the local populations collapsed. European-introduced diseases had a devastating effect on local groups; while after the introduction of the spread of the horse onto the Plains, nomadic raiding groups (i.e., first the Apache, then the Comanche) from the north and west forced most local groups to abandon much of the area. Most groups were simply destroyed by the combined effects of the nomadic raiders and the foreign diseases introduced by the Europeans. Today, the only Native American group who has claimed Central Texas ancestry is the Tonkawa, and descendents of some of the "families" that sought refuge in the Spanish Missions, but are not federally recognized as valid groups (Black 1989:33). Nevertheless, it is clear from excavations in historic sites in San Antonio that the process of integrating Indians into European society was accompanied by a great deal of cultural survival, and even European borrowing of Indian material culture (Hinojosa and Fox 1991:113).

European-American History

Introduction

Texas in general, and San Antonio and Bexar County in particular, have had both a rich and a complex history that stretches almost as far back as the presence of Europeans in North America. The following discussion is intended to be only a general overview of this history, and for more detail the reader is referred to the sources listed in the bibliography. For the sake of convenience, this section has been divided into several subsections, covering various time periods, including the period of Spanish exploration and early missionizing efforts (1519-1718), the period of permanent Spanish colonial settlement (1718-1821), the period of Mexican statehood (1821-1836), the Texas Republican period (1836-1846), the early period of American statehood (1846-1865), the post-Civil War period (1865-1900), and the twentieth century (post-1900). The foundation and development of Lackland AFB is explored over three stages during the twentieth century: Establishment of Lackland AFB – Kelly Field Annex (1913-1945), Lackland AFB (1945-Present), and the Lackland Training Annex (1954-Present).

Early Spanish Exploration and Missionization (1519-1718)

The initial Spanish presence in Texas began with the arrival of Alonso Alvarez de Piñeda on the Texas coast in 1519 to explore the coast of the Gulf of Mexico (Webb 1952a:380). Attempts to explore and colonize continued sporadically, and in 1528, Alvar Nuñez Cabeza de Vaca landed accidentally on an island known to the Spanish as *Malhado*, possibly Galveston Island (Webb 1952b:261–262; Winship 1990:1–4), when a boat he had been marooned on was driven ashore. Several scholars have suggested that Cabeza de Vaca and his companions eventually traveled up the Guadalupe or San Antonio River valley after leaving the coast and thus passed close to the San Antonio area. Although their exact route is still in dispute, it is known that his small group managed to cross the continental divide and in 1536 were met by Spanish slave catchers in Sonora or Sinaloa, Mexico, and subsequently taken to Culiacan (Webb 1952b:262–263; Winship 1990:1–4). Exploration of the region continued apace. It was clear by 1550, however, that there were no golden cities or wealthy countries to conquer north of Mexico. Consequently, Spanish expansion into the American southwest and Texas slowed, leaving eastern Texas largely unexplored.

The indigenous people in what is now southern Texas represented a heterogeneous series of perhaps three to four dozen district bands of hunters and gatherers (Wade 1998). The were once considered to be designated under the rubric of the "Coahuiltecan groups," which refers to the linguistic designations for these people living in the Mexican state of Coahuila before the creation of Texas (Newcomb 1966). But recent studies have suggested that they spoke at least two and perhaps four distinct languages including Sanan (Johnson and Campbell 1992). Recent developments have called for the abandonment of the term "Coahuiltecans" as an ethnic term, since it does not refer to any known group (Hester 1998) or recognize the reality of broad cultural diversity. Spanish Mission baptismal, marriage, and death records record the following groups residing near present San Antonio in the early eighteenth century, which we collectively regard as "indigenous groups": Ervipiame, Jumano, Jumee, Macocoma, Mescal, Mesquite, Muruame, Papanac, Pataguo, Pausane, Siaguan, Sijame, Terocodame, Teimamar and Yorica (Wade 1998:632).

Tension between the indigenous groups and the Spanish, and indigenous groups and the Apaches, escalated during the late sixteenth and early seventeenth centuries in southern Texas. Ultimately the Spanish protected the indigenous groups against the Apaches with the establishment of the first two Spanish missions in 1671. Eventually, four missions serving an area running north-south across the Rio Grande were established on the Coahuila frontier (John 1975:172–174). The French, led by René Robert Cavelier, Sieur de La Salle, began intruding into Eastern Texas and established Fort Saint Louis in 1685 (John 1975:182). The Spanish, fearing an increased French presence in East Texas, reacted by establishing missions and presidios in East Texas to act as a buffer against further French encroachment into the region (Pool 1975:28; Webb 1952b:483–484). Fray Massanet and de Teran and came into the region of the Medina and San Antonio rivers in 1691, both commenting on the fine plains and large numbers of buffalo they encountered (McGraw and Hindes 1987:64). Fray Massanet had called the area San Antonio de Padua, in honor of St. Anthony of Padua, and had suggested that it would make a suitable location for a mission. De Leon reportedly left a small garrison of men there, and although some have taken this to be the beginning of the Presidio of San Antonio (McGraw and Hindes 1987:64), permanent settlement of the San Antonio area was still 27 years in the future.

Missionization in Texas reached its culmination in May 1718 when the locations for a new mission on the western bank of the San Antonio River and a town three-quarters of a league away near San Pedro Springs were designated (de la Teja 1991:29). The former was to be called Mission San Antonio de Valero and the latter the Villa de Bexar. Due to a lack of men and material, the construction of the town and mission did not occur until 1719, marking the beginning of permanent Spanish settlement in Texas.

Spanish Colonial Settlement (1718-1821)

The three-pronged approach to settlement that the Spanish implemented involving presidio, mission and civilian settlements, proved to be more successful that the establishment of mission and presidio or presidio alone (Gilmore 1991). This was certainly true in the case of San Antonio. A total of five missions was built on the San Antonio River, all within a 12-mile radius of the present city. Mission San Antonio de Valero was established first in 1718, followed shortly by Mission San Jose in 1720. Eleven years would pass before Missión Nuestra Señora de la Purisima Concepción, Missión San Juan Capistrano, and Missión San Francisco de la Espada were found from East Texas to San Antonio in 1731.

Population growth was slow in the area. Initially most inhabitants were members of military households. Alarçon's first settlement had included "an engineer, stone mason, blacksmith, and a number of women and children" (de la Teja 1988:56). By 1721, San Antonio had become a series of wood and mud huts (*jacales*), which was typical of the initial stages of a frontier settlement. Land use outside the cities was chiefly confined to large-scale ranching activities. Ranching activities during the eighteenth century were very relaxed, attributable in part to the small population and lack of market. Round-ups amounted to little more than the gathering of wild, unbranded stock when meat or hide and tallow was needed (McGraw and Hindes 1987:71). Some ranches in Bexar County, however, were more productive (McGraw and Hindes 1987:72).

During the mid-1700s, the missions of San Antonio attracted a variety of Indian groups, primarily hunter-gatherers who were chiefly Sanan and Karankawan. The missions also attracted Indians of other origins, some of whom were fleeing Spanish disruptions in Nuevo Leon and other regions of northern Mexico (Hester 1989:200). However, not all Indian groups were interested in what the missions had to offer. Mission settlements were disrupted frequently from 1721 to 1749 by raiding Lipan Apaches. Even after a formal truce had been signed in 1749, thievery and limited hostilities took place throughout the rest of the century (de la Teja 1988:61). Hostilities were also experienced with various Comanche bands, which disapproved of the tentative link between the Spanish and the Apache during the last half of the 1700s.

Outside political factors during the latter half of the eighteenth century had a great impact on the region. The completion of the Seven Years War (1754-1762) and the signing of the Treaty of Paris in 1763 resulted in the French and Spanish ceding most of the lands east of the Mississippi to England, and Spain acquiring the Louisiana Territory from France. This, of course, put an end to the years of Spanish paranoia and called for a reassessment of the situation in New Spain (McGraw and Hindes 1987:74). Local effects included Bexar being selected as the new provincial capital. Growth continued at a slow but steady rate, encouraged by the American Revolution. As a result of the removal of the French threat, the strategic status of the Missions declined and they were eventually secularized by 1793. With Spain and America eager to avoid a costly war, the Louisiana Purchase in 1803 brought about the establishment of a "no-man's land" between the Texas and Louisiana border. In 1810, Spanish rule began to deteriorate rapidly. Discontent in the provinces resulted in ten years of bitter strife, which culminated in Mexican Independence in 1821.

In the Bexar County region, filibusters made forays into the province encouraged as they were by the claim that Texas was actually part of American Territory. The local governing body changed hands frequently as a result of battles waged between Spanish loyalists and revolutionaries. In one particularly bloody incident, 1,000 persons in the province who were accused of being revolutionaries were rounded up and executed or exiled (Fehrenbach 1968:130).

Mexican Statehood (1821-1836)

Following Mexican Statehood, conditions around Bexar slowly improved. In fact, prior to Mexican Independence, Moses Austin had applied for and received permission to bring 300 families of American colonists to Texas in 1821 (Fehrenbach 1968:135). Although he died before ever seeing his grant, he convinced his son, Stephen F. Austin, to carry out his plans (Fehrenbach 1968:136; Reese et al. 1994:26). Because of liberal land policies, Austin had many volunteers eager to accompany him. Colonists had to be of good moral character, were required to become Spanish (then Mexican) citizens, and were also required to convert to Catholicism (not rigorously enforced). Under Spanish/Mexican law, land was distributed as follows: one labor (71.6 ha [177 ac]) to each family engaged in farming, one league (1,792.0 ha [4,428 ac]) to each family engaged in ranching and one-third league (597.3 ha [1,476 ac]) to each single rancher (Fehrenbach 1968:140). The government charged a flat title fee and Austin received a fee. The law required the land to be developed within two years or forfeited. In all, 297 titles were issued of which only seven were forfeited. Most of the settlers claimed to be ranchers for obvious reasons.

Beginning in 1823, immigration laws were changed to allow *empresarios* to offer lands to heads of families willing to settle in Texas. In San Antonio, the Republic Constitution of 1824 affected local politics. Former Spanish provinces were turned into sovereign states. Texas and Coahuila were combined into one state with Saltillo named as the capital. The legislature of Coahuila passed its own colonization laws in 1825, which continued to open the area to European-American settlement. After a decade of *empresarios*, there were over 20,000 European-Americans and their slaves in Texas. The *empresarios* managed to bring colonialization further in one decade than the Spanish government had in three centuries.

One of the effects of increased immigration was the opening and improvement of roadways, many of which followed the old Spanish *caminos*. The influx of settlers into the region brought changes in local politics as European-American immigrants gained influence and Mexicans were politically overshadowed. Alarmed by this situation, the Mexican government passed the Decree of April 6, 1830, which prohibited the further "colonization of Mexican territory by citizens of adjacent countries - meaning the United States" (Fehrenbach 1968:165). It also prohibited the importation of slaves, further alienating European-American settlers (Reese et al. 1994:27).

From 1832 to 1835, a series of conflicts and temporary solutions continued to drive a wedge between Colonial Texas and Mexico. When meetings were held in San Felipe, the European-American immigrants adopted resolutions and framed a state convention resulting in separation from Coahuila and the formation of a new state. In 1835, a Mexican army crossed the Rio

Grande bound for San Antonio to squelch the rebellious Texans. A call to arms was issued and hostilities began in earnest (Fehrenbach 1968:193; Reese et al. 1994:27). Many of these conflicts, later known as the Texas Revolution, were fought in and around the City of San Antonio and culminated in the battle at the Alamo (formerly Mission San Antonio de Valero) in the Spring of 1836. During the siege of the Alamo, elected representatives from the colonies were meeting at Washington-on-the-Brazos, where the Texas Declaration of Independence was signed on March 2, 1836. After Santa Anna's victory at the Alamo, the Texans defeated his forces at the Battle of San Jacinto and the Republic of Texas was born (Reese et al. 1994:27).

The Republic of Texas (1836-1846)

In 1836, the Republic of Texas was a "backwater." The government of the new Republic was loosely organized and there were no schools (Fehrenbach 1968:247). Most of the 40,000 residents were subsistence farmers. When the first elections were held in the new Republic, an overwhelming majority voted to approve a union with the United States. The issue of slavery, however, stood in the way of annexation for 10 years. The old Spanish/Mexican conventions, though, were quickly replaced with the more familiar American customs (Reese et al. 1994:27).

The population of Bexar County, formed in 1836, continued to be predominantly Mexican. The new Republic, however, was eager to encourage immigration. It did so by offering its most abundant commodity, land. Land disbursal policies were governed by the Constitution of the Republic of Texas. Texans belonged to one of three classes of citizens, based on their time of arrival in the Republic, and were accorded rights to land dependent on their status. Heads of households were distinguished from single men. For example, First Class citizens were those who arrived before March 2, 1836. A First Class head of household was entitled to one league (179.2 ha [4,428 ac]) and one labor (71.6 ha [177 ac]), whereas a First Class single man was entitled to one-third league. It was incumbent on each settler to locate the land, often unavailable in the county in which he currently resided; to provide witnesses who would attest to his (or her) arrival date; and to pay for the survey and the filing fees. In most counties, the Board of Land Commissioners worked without delay because of the extreme importance of land to the citizens. Land was also distributed in differing amounts for military service (Fehrenbach 1968:283). Later, the land laws under the State of Texas were set up in much the same way, with land also being granted preemptively, through "squatters' rights" (Reese et al. 1994:27-28).

The land grant system, especially as it existed during the Texas Republic period, had a significant effect on land in the Lackland AFB area. Several landowners had holdings on the land that now comprises Lackland AFB, but two individuals had a particular impact on the City of San Antonio and Lackland area during the mid-1800s (Reese et al. 1994:27-28). Samuel Augustus Maverick, son of a prominent South Carolina family, arrived in San Antonio de Bexar on September 8, 1836 (Chabot 1934:3). In 1836, he married Mary Ann Adams during a trip to Alabama; she would later become a chronicler of local history. Maverick, intent on concentrating his holdings in Texas, sold valuable properties from New York and Alabama and invested the proceeds in Texas land (Chabot 1934:3). He was deeply involved in local politics. In addition to being a Bexar representative at Washington-on-the-Brazos, he was mayor, treasurer, and alderman of San Antonio, and held many state offices. At the time of his death in 1870, he was purportedly one of the largest landowners in the United States (Chabot 1934:6). Maverick owned a great deal of land in and around the Lackland AFB area (Reese et al. 1994:28).

The second individual to have a great impact in the region, and specifically on the Lackland AFB area, was Nathaniel Lewis, born near Nantucket, Massachusetts in 1806. An adventurer, he eventually found himself in Texas “without a penny in his pocket” (Chabot 1937: 327-328). He arrived in San Antonio around February of 1836 and decided to settle there. He had soon started a thriving business on the Main Plaza, selling goods from the East Coast (Chabot 1937:328; Reese et al. 1994:28). In addition to his dry goods store, Nat Lewis was also deeply involved in the cattle and horse business. He had large land holdings on which he ran his stock, much of it in and around the Lackland area. At one time, Lewis owned all of the Rafael Herrera, E. F. Morales, Francisco Rivas, and N. Flores surveys. It is possible that he used some of it for ranch land, although it is certain he never lived there. His house in San Antonio can still be seen at 112 Lexington. Nat Lewis, Sr., died in San Antonio in 1872. Sometime before 1890, the property in the Lackland area passed from the Lewis family. That tract would eventually be known as the McKay Ranch (Reese et al. 1994:28).

Bexar County was created in 1837 and San Antonio was named as the county seat (Webb 1952b:540). Anglo-European and European-American settlements expanded north into the Central Texas plateau and west into the formerly Mexican rangelands of South Texas (Fox 1989:89). A steady stream of German immigrants began settling in the Texas hill country north of San Antonio after about 1840. With this northward and westward expansion, large-scale cattle ranching came to dominate the economy of Central and South Texas, and by the 1850s, Texas was exporting cattle on a grand scale (Fox 1989:89). Statehood was finally granted on December 29, 1845, after Mexico again tried to reclaim Texas as a part of its territories in 1837. During this dispute, San Antonio and Bexar County had once again become the setting for numerous hostilities between Mexican and Texan forces.

Early U.S. Statehood: 1846-1865

Development and industrialization flourished after the annexation of Texas by the United States (Fox 1989:89). Commerce, which had faltered during the hostilities with Mexico, now improved. San Antonio became a center for stagecoach travel into the region (McGraw and Hindes 1987:95). Emigration from the United States increased rapidly, as did the arrival of refugees from abroad. In 1850, San Antonio contained about 3,500 inhabitants. By 1856, the population swelled to 10,000 (Webb 1952b:540), and was diversified as Europeans, many of German ancestry, moved into the area and became the dominant influence (Fehrenbach 1968:285; Reese et al. 1994:30). The ongoing “Americanization” of all aspects of Texan life was demonstrated by a growing use of “Anglo” styles of architecture and building materials. While absentee landowners owned some of the areas around San Antonio, this was not the case throughout most of the region where small subsistence farming predominated (Reese et al. 1994:30).

Settlement continued to expand westward, generally at the expense of Native American groups. Towns grew up at important road intersections and river crossings. In Central Texas, most goods were laboriously moved overland from coastal ports by two-wheeled Mexican carts and freight wagons (Fox 1989:89). In response to these transport difficulties, local, small-scale industries began to develop; mills and other water-powered operations were constructed on falls along major rivers. The need for building stone also encouraged quarries and lime-burning operations in the Hill Country. Other small manufacturing industries took root in San Antonio and the city developed into “a frontier entrepot for the entire central Texas region” (Fox 1989:90; Reese et al. 1994:30).

In the Lackland area itself, specifically the western half of the J. M. Becerra Survey, the deed records contain a reference to a 1851 transaction made from Enoch Jones and J. W. Smith to Christopher C. Gove. Mr. Gove received this property in three different transactions in 1852 and 1856. The documentation of the sale of 546.3 ha [1,350 ac] of this property in 1856 suggested the presence of a structure or structures, and specific mention is made in the deed to the following:

> . . . two negro slaves, one a woman about forty years old and the other a boy about ten years old also forty eight head of cattle fifteen hogs, one ? one yoke of oxen one ox wagon one buggy & harness, together with my stock of fowls of every sort all my household and kitchen furniture my carpenters & farming tools and utensils of every sort the corn beans and other products & all materials now in & pertaining to my said farm . . ." [BCDR nd:41].

The land, which is the eastern section of the western half of the Becerra Survey, can be more accurately described as a strip of land that extends from the northern boundary to the southern boundary of the Becerra Survey (which coincides with the Medina River). Only about the northern third of this property, therefore, would be currently located on Lackland AFB. This section of land was sold to Martin and Lucinda Kosta. Although the date they sold the property was not discovered, it is known that by 1913 the property was in the possession of D. H. Dolan. There was a structure located on the 1903 USGS sheet that is probably included in this section of land. A check of the 1850 to 1860 tax records fails to reveal either Mr. Gove or Mr. Kosta paying property taxes on anything in the Becerra Survey. Mr. Gove is referenced in the census records for 1850, citing that he was a 35 year-old-male from "N.Z." (Reese et al. 1994:35, 39).

During the 1850s, the political situation in Texas and throughout the United States, was uneasy. Texas voted overwhelmingly in February 1861, to follow the rest of the South in seceding from the Union. In general, the region around San Antonio fared better that most during the Civil War. San Antonio was named as the headquarters for the Cavalry of the West in 1864 and saw some benefit from this posting. Some smaller communities actually benefited from the increased travel through the region (McGraw and Hindes 1987:99; Reese et al. 1994:39). The route that was known as "the military road" led northwest from San Antonio. Apparently, it ran almost due west from San Antonio to Leon Creek, at which point it turned northwest and ran relatively straight to Bandera Pass. Near the boundary between Bandera and Kerr counties, it passed out of Bexar County at the headwaters of San Geronimo Creek, possibly somewhere near the present-day town of San Geronimo (Pressler 1858). This road may have passed as close as 2-3 miles south of the Lackland area and may be the source of the names "Government Canyon" and "Government House" (Pressler 1858; Reese et al. 1994:39).

Postwar Civil War Period: 1865-1900

The years immediately following the Civil War were ones of economic setbacks and subsequent adjustments all over Texas. During the period of "Reconstruction" which followed, Federal soldiers occupied the state and Radical Republicans ran the government. Much of the San Antonio area had suffered from a severe drought in 1863, the effects of which lasted beyond the end of the war (McGraw and Hindes 1987:100). Cotton and land prices went down, and where slaves had once worked large plantations, tenant farming became the norm. In 1869, many residents left the city when a severe cholera epidemic further devastated San Antonio (McGraw and Hindes 1987:100).

Despite these upheavals, Texas in general, and San Antonio in particular, began the slow return to economic stability, aided by existing economic conditions (McGraw and Hindes 1987:100; Reese et al. 1994:39). The first of these was the large numbers of cattle running freely in the area, which formed the basis for the developing South Texas cattle industry. San Antonio played an important role throughout the 1870s as a staging center for the great cattle drives to the northern railheads. The second condition was a large freed-black population that chose to stay in the area rather than emigrate. The continued presence of blacks resulted in the continuation of large farms and ranches now based on wage labor or tenancy, rather than slavery. Finally, a local wool industry began to develop in San Antonio (Reese et al. 1994:39).

The arrival of the railroad in San Antonio in 1877 was the most important event during the postwar period, as it was in most of Texas (Fox 1989:90). The railroad made San Antonio a shipping point for cattle and farm products and brought with it improved transportation for both people and merchandise (Webb 1952b:540). Ease of travel also contributed to continued immigration and an increase in population. During the latter part of the nineteenth century, the extensive amount of land suitable for range led to a cattle industry boom in Central Texas, while the increased population caused a period of land speculation (Reese et al. 1994:40). Economic depression, brought on by drought in the late 1880s, changed the face of Texas agriculture permanently. Many ranches were lost to foreclosure or subdivided into small farm holdings that were sold to farmers.

Twentieth Century: post-1900

By 1900, San Antonio was the crossroads for five railroads and had a population of 53,321 (Webb 1952b:540); the population of Bexar County as a whole stood at 69,000 individuals (Taylor et al. 1991:118). At that time, major industries included flour mills, foundries, and breweries; educational institutions included 29 private schools and colleges (Webb 1952b:540). Subsequent to 1900, overall expansion in the economy of Bexar County was rapid. Although the county contributed only about one percent of the total oil production for the state as a whole, San Antonio developed as a headquarters for producers and operators working in other parts of the state. At the same time, the extensive deposits of stone, clay, sand, and gravel in the county continued to promote the development of the building supplies industry. Agriculture and stock raising continued to be important as approximately 70 percent of Bexar County was in farmland, and more than half of this acreage was rangeland (Reese et al. 1994:41; Taylor et al. 1991:119).

The establishment of San Antonio as a military center added a new dimension to the region's economy during the twentieth century. The San Antonio Arsenal dated to 1859, prior to the Civil War. World War I spurred the addition of facilities at Brooks AFB, Camp Travis, Camp Stanley, Camp Bullis and Camp Kelly. Randolph AFB followed in 1928, in the years between the wars (Reese et al. 1994: 41; Webb 1952b:540).

Establishment of Lackland AFB – Kelly Field Annex: 1913-1945

Brigadier General George P. Scriven, U.S. Army Chief Signal Officer testified before the U.S. House of Representatives in August 1913, concerning the establishment of a military aeronautical center in San Antonio, Texas. The center of military aviation envisioned by Scriven had its beginning on May 7, 1917, with the establishment of Camp Kelly. The future base was to be located on a tract along Leon Creek, chosen for the relatively level land and access to the International and Great Northern Railroad shops and roundhouse, as well as to the tracks of the Southern Pacific Railroad (Isbell 1962:67). Abundant water was available from artesian wells.

U.S. involvement in World War I magnified the importance of military aviation and accelerated the urgency of developing Camp Kelly, which was one of only four operational Army flying fields in the country. An Engineering Department, a Recruit Camp and Concentration Center, primary flight training camps, an aircraft mechanics training program, a school to train ground officers, an aviation supply depot, and primary and advanced flying schools were among the activities located here during the war (Freeman 1997:L-31). As American mobilization continued into the summer of 1917, it became clear that the land originally acquired for Camp Kelly was insufficient to accommodate the new facilities and the growing number of recruits. San Antonio Chamber of Commerce obtained leases for additional land that was then sublet to the government. The property, which became known as Kelly Field No. 2, was adjacent to Camp Kelly and extended west and south to Leon Creek. The School of Advanced Flying, unquestionably the most important program to use the facilities at Kelly Field No. 2 during World War I, was authorized by General Order No. 70, which was issued October 3, 1917. Recruits continued to pour into the facility, creating a need for additional buildings at Kelly Field No. 1 in September 1917 to accommodate them and the various programs under development.

Kelly Fields No. 1 and No. 2 reached their largest population during World War I in December 1917, when more than 1,100 officers and 31,000 enlisted men were stationed there. When the Armistice brought an end to the fighting in Europe on November 11, 1918, more than 30 new Air Service flying fields were in operation. Following the Armistice, though, strong American isolationist views reasserted themselves and Congress cut military appropriations dramatically. With this loss in funding, the Air Service experienced cutbacks in personnel and equipment. From 1921 to 1925, appropriations by Congress for the purpose of Army construction were cut by 42 percent. Despite these cutbacks, Kelly Fields No. 1 and No. 2 continued to play an important role in national defense. In 1925, Kelly Fields No. 1 and No. 2 were officially separated and designated as Duncan Field and Kelly Field, respectively, but changes to the installation were mostly in name only.

In March 1943, the depot was renamed San Antonio Air Service Command (SAASC). This name was used until 1944 when the depot was renamed San Antonio Air Technical Service Command, a name used until 1946. Kelly AFB probably reached its peak of production in late 1944, when air combat declined or ceased in the North African, European, and Mediterranean theaters and aircraft were shipped back to the United States for repair and storage (San Antonio Air Logistics Center, Office of History 1980:92, 102). The installation expanded in size once again in 1945 when it annexed nearby Normoyle Ordnance Depot, which served as a depot for Fort Sam Houston during World War I. With the 1943 expansion and the acquisition of Normoyle in 1945, the San Antonio Air Technical Service Command became the largest air depot in the United States.

Lackland AFB: 1945-Present

By July 1945, many of the facilities at SAASC were utilized by the Army Air Force (AAF) Personnel Distribution Command to receive returning veterans and reassign them. With massive demobilization of the Army Air Forces, SAASC was redesignated as the Army Air Forces

Military Training Center, on 1 February 1946. The purpose of the redesignation was to consolidate all enlisted basic training. All new recruits would report to the training center for Basic Training School (BTS), thus coining the phrase "Gateway to the Air Force." To reinforce the consolidation, the Officer Candidate School (OCS) was transferred to the military training center from Maxwell Field (Benson and Jones 1975:5, 8–9). The Army Air Forces Military Training Center was redesignated as the Indoctrination Division, Air Training Command (IDTRC) on 1 November 1946. Lackland AFB was officially established on 1 July 1947 when the land that the IDTRC occupied was officially renamed Lackland Air Base. That land began as a desolate bombing range, called "the Hill." Aside from surveys and records of land transactions, little is known about land use in the Lackland area. In general, settlement in the area appears to have been sparse even into the late nineteenth century. A 1903 USGS topographic map reveals only four structures within the confines of the base. Choice of this site for the base may have been related to the fact that the land was so sparsely settled. Training continued to be the primary mission and during World War II, over 100,000 personnel were trained as officers at the Hill (37 Training Wing History Office [TRW/HO] 1994:ix-xi).

Overcrowding was a prevalent problem at the newly established Lackland AFB. To provide a more permanent solution, Air Training Command (ATC) solicited bids in 1951 for barracks for 12,000 men ($26 million), additional training facilities ($1 million), and classrooms ($750,000). Later that year, the United States Air Force (USAF) asked Congress for another $63.7 million for additional new construction at Lackland. Construction began in 1951 on 129 "I-dormitories" in the 7000 and 10000 building areas at Lackland. Besides housing, Lackland AFB constructed other support facilities for the basic training mission. To handle the huge number of recruits flowing into the base on a daily basis, a wooden framed, recruit-processing center, costing $572,093 and known as "the Green Monster," because it was painted green, was completed in November 1952 (37 TRW/HO 1994:19).

During the mid-1950s and early 1960s, the variety of Lackland training programs increased. The 3700th Air Force Indoctrination Wing was redesignated the 3700th Military Training Wing (MTW) due to the addition of nonresident training. Officer training was also stressed at Lackland with the addition of the Pre-Flight Language Training Course and the Chaplain Training Program. In 1955, Basic Military Training was restructured to consist of two phases. Phase I (six weeks) of basic training was conducted at Lackland and Phase II (five weeks) was conducted at a technical school (Benson and Jones 1975:21–22). With the addition of the 3275th Technical Training Group in 1956, the Lackland training mission expanded to include technical training programs. Cryptographic and Personnel Training were also transferred from Scott AFB, Illinois, in 1957. A new phase of training was developed in 1957 with the establishment of the USAF Marksmanship Center. In 1957, the Sentry Dog Program, which would later play an important role in "Project Top Dog 45" during the Vietnam War, was also established (Benson and Jones 1975:24–25, 33). In 1957, Lackland AFB received its first, large, permanent structure. Wilford Hall, the nine-story, 500-bed hospital, was constructed on the northern end of the base and replaced 94 temporary buildings that had been used by the base for hospital functions. In 1959, the 3700th Military Training Wing was redesignated the Lackland Military Training Center (LMTC). Because of the expansion of the Air Force in the 1950s, the service was in further need of officers; thus, an Officer Training School (OTS), a three-month-long intensive course to develop leadership and skills for recruits with four-year college degrees, was opened at Lackland AFB. Within several years, OTS had become the major source of officers for the Air Force (Winkler 1997:52).

In the mid 1960s, with the war in Viet Nam escalating, Lackland's existing built environment was insufficient for handling the increased number of trainees. Between 1951 and 1966, more than 400 buildings were constructed at Lackland and at least 200 older buildings, including barracks and dining halls, were demolished. In spite of these improvements and the new facilities, Lackland did not have enough space for the increased number of recruits to support the Southeast Asian buildup. Thus, in 1969, ATC approved a $21 million expansion at Lackland that included the construction of five Recruit Housing and Training (RH&T) dormitories at a cost of $15 million (Dalton 1966:12–14; Trest and Hines 1978:20). During the late 1960s and early 1970s, many changes were evident at Lackland. Major construction included five Recruit Housing and Training dormitories, two theaters, a dispensary, a library, two visiting officers' quarters, a shopping center, a sentry dog veterinary clinic, and a Security Police operations building.

CHAPTER 4
RESEARCH GOALS AND METHODS

The cultural resources investigation documented in this report was undertaken with three primary management goals in mind:

1. to locate all historic and prehistoric archaeological resources occurring within the designated APE;
2. to evaluate the significance of these resources in regard to their potential for inclusion in the NRHP or for designation as an SAL; and
3. to make recommendations for the treatment of these resources concerning the proposed undertaking, based on their NRHP and SAL evaluations.

Ultimately, management decisions regarding cultural resources properties are a function of the potential importance of such properties in addressing defined research needs. The assessment of significance of a cultural resource property is based on federal and state guidelines and regulations, which are reviewed below.

NRHP ELIGIBILITY

Cultural resources investigations generally are undertaken with the purpose of identifying resources that are listed on or eligible for inclusion in the NRHP. Any cultural resource that is listed on or eligible for inclusion in the National Register is known as a "historic property," and the term "eligible for inclusion in the National Register" includes both properties formally determined as such by the Secretary of the Interior and all other properties that meet National Register listing criteria (36 CFR 800.2). The criteria to evaluate properties for inclusion in the NRHP are codified under the authority of the National Historic Preservation Act of 1966, as amended. These criteria are presented in 36 CFR 60.4 (a–d), which provides the guidelines used to determine a site's eligibility for inclusion in the National Register. Subsequent to the identification of relevant historical themes and related research questions, these four criteria of eligibility are applied:

> The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, material, workmanship, feeling, and association and

(a) that are associated with events that have made a significant contribution to the broad patterns of our history; or
(b) that are associated with the lives of persons significant in our past; or
(c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
(d) that have yielded or may be likely to yield, information important in prehistory or history [36 CFR 60].

SAL ELIGIBILITY

At the state level, archaeological sites may be considered significant and be recognized or designated as an SAL, provided that at least one of the following conditions is met:

1. The archaeological site is situated on lands owned or controlled by the State of Texas or one of its political subdivisions; or
2. The archaeological site is situated on private land that has been specifically designated as an SAL . . . and fits at least one of the following criteria:
   (A) Preservation of materials must be sufficient to allow application of standard archaeological techniques to advantage;
   (B) The majority of artifacts are in place so that a significant portion of the site's original characteristics can be defined through investigation;
   (C) The site has the potential to contribute to cumulative culture history by the addition of new information;
   (D) The site offers evidence of unique or rare attributes; and/or
   (E) The site offers a unique and rare opportunity to test techniques, theory, or methods or preservation, thereby contributing to scientific knowledge [Texas Natural Resources Code 1977; Title 9, Chapter 191, Texas Antiquities Committee, Section 191.094 and Chapter 41.7, Antiquities Code of Texas].

ARCHIVAL RESEARCH

Prior to fieldwork, GMI personnel performed a search of the available data sources. Records maintained by the Texas Historical Commission (THC) and TARL at the University of Texas at Austin were queried to identify known sites within and proximate to the APE (within 1 km). A literature review to obtain information from previous investigations and data from geologic maps, soil surveys, and aerial photographs was undertaken. Historic maps—including nineteenth- and twentieth-century county maps held in the Library of Congress and early twentieth-century soil maps produced by the U.S. Bureau of Chemistry and Soils—were also consulted.

ARCHAEOLOGICAL SURVEY

The archaeological survey methodologies employed by GMI in the current study are in accordance with the State of Texas Antiquities Code and the guidelines of the Council of Texas Archeologists (CTA) as approved by the Texas Historical Commission (THC) office of Division of Archeology and overseen by the State Historic Preservation Officer (SHPO). The Department of the Interior guidelines for addressing cultural resources were also followed.

A pedestrian walkover was initially employed within each of the proposed alternative routes. Ground surfaces were inspected and exposed areas along stream cutbanks were observed for the presence of cultural materials and buried living surfaces. Each of the proposed roadways would encompass a width of approximately 50 feet with lengths of approximately 1.34 mi for Alternatives 1 and 2 and 2.05 mi for the Proposed Action. Therefore, according to CTA/THC standards, a combined total of 54 total shovel tests were required to adequately sample the total area encompassed by the proposed routes (16 shovel tests per mile). During the survey, however, it was determined that this number was unnecessary due to extensive disturbances encountered within each proposed route (discussed in the Results section below). In short, extensive quarrying within the Leon Creek floodplain and numerous construction activities conducted along U.S. Highway 90 and Growdon Road have significantly impacted the integrity of the deposits within the majority of the area encompassed by the proposed routes. As a result, shovel tests were judgmentally excavated in areas that appeared to contain intact deposits. The total number of shovel tests excavated during this process was 39. While this number is significantly less than the 55 shovel tests initially estimated prior to fieldwork, the number is sufficient given the level of disturbances encountered in the field. Shovel tests were approximately 30-x-30-cm square and were to be excavated to sterile subsoil or to 80 cm below surface (bs); however, many of the shovel tests were terminated upon contact with impenetrable subsurfaces (e.g., concrete, asphalt, dense gravels). Soils for each shovel test were screened through 0.635-cm (0.25-inch) hardware cloth for any cultural material.

Originally, backhoe trenching was planned within the Leon Creek floodplain and potentially along terraces containing Holocene alluvium; however, trenching was also determined to be unwarranted for the above stated reasons. Specifically, quarrying within the Leon Creek floodplain has significantly impacted deeply buried Holocene sediments. Pleistocene gravels which typically underlay Holocene alluvium in this region were commonly observed on or just below the ground surface throughout the floodplain where the routes for Alternatives 1 and 2 are positioned. This indicates that quarrying penetrated through the Holocene age sediments in this location. A 1963 aerial image shows that this disturbance was widespread and occurred throughout the floodplain (Figure 4). Thus, the potential for deeply buried intact archaeological deposits within the floodplain portions of the APE is considered to be very low.

All materials generated by this project will be permanently curated at the Center for Archaeological Research at the University of Texas at San Antonio. In addition, field notes detailing the survey conditions, landscape features, level of disturbance, and initial interpretations of the cultural resources were maintained by the project archaeologist. Documentation for each shovel test included stratigraphy, soil characteristics, and the presence or absence of cultural materials. Digital photographs were taken throughout the survey to record the general topography, environmental conditions, current land use, and other factors.

SITE CRITERIA

A site is defined on the basis of content and extent. When a shovel test yields cultural material, additional shovel tests are excavated in a cruciform pattern at 5-m (16.5-ft) intervals around the initial test until two sterile shovel tests are encountered in each cardinal direction. In the absence of visible archaeological features such as structural foundations, a site is defined within the extent of positive shovel tests. For surficial materials or shovel test contents, a site is defined as five or

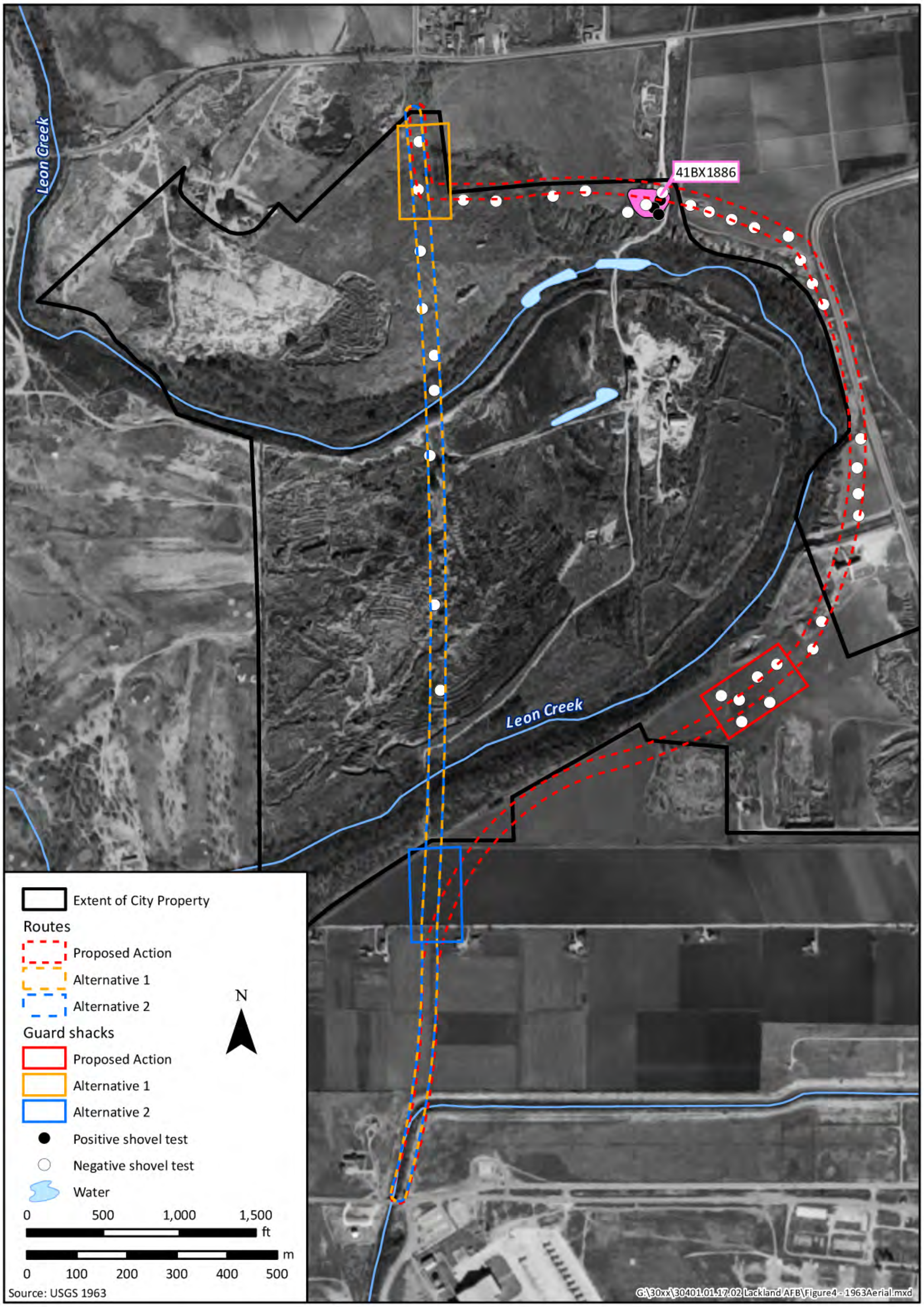

Figure 4. 1963 aerial imagery showing disturbance within the Leon Creek floodplain.

more cultural items of at least two different artifact materials or classes (e.g., prehistoric stone tool manufacturing debris exhibiting different raw materials, or manufacturing debris in combination with stone tools; or several different historic-era ceramic [or glass] types, or ceramics in addition to glass) within a 20-m (65.6-foot) square. Cultural remains meeting these criteria are designated as a site, recorded on a Texas Archaeological Site Data Form, and submitted to TARL. Conversely, the discovery of one or two cultural items (either surface or subsurface) not meeting these criteria is considered an isolated occurrence of human activity and is simply documented by location and content as a “locality”; likewise, historic-era material representing an obvious single-event trash dump is not considered a site, with only location and content documented.

CHAPTER 5
RESULTS

ALTERNATIVES 1 AND 2

Alternatives 1 and 2 extend from U.S. Highway 90 and continue south through the Leon Creek floodplain and end south of an agricultural field located to the south of Morey Road (see Figure 2). The northernmost end of the routes cut through an open lot before descending into the Leon Creek valley. According to personnel from the City of San Antonio, the open lot, which both alternative routes extend through, was once used as a landfill (see Figure 2). The exact boundaries of the landfill could not be specified, but according to Shovel Tests 16-18, excavated south of U.S. Highway 90, it is clear that portions of the lot that the routes pass through are highly disturbed. For example, each shovel test encountered disturbed deposits consisting of concrete, limestone fragments, and gravels (Table 1). In addition, the remainder of an asphalt lot was clearly visible on the surface within the open field (Figure 5). It is very unlikely that the installation of Alternative 1 and 2, including the Alternative 1 Guard Shack (see Figure 2), would encounter any intact archaeological materials within the open lot.

South of the open lot, very dense vegetation comprises the wooded area along the Leon Creek meander. The terrain encountered within this area was very uneven and did not appear natural. Sequences of small hills with very dense vegetation resembled push piles and indicated that the area was likely impacted to some degree by quarrying activities. Shovel Tests 19 and 20, excavated in this area between the open lot and Leon Creek encountered dense gravels and could not be excavated below 20-30 cmbs. Only a small portion of floodplain, approximately 20-m wide directly adjacent to the current channel, appeared to contain intact sediments. Shovel Test 21 was excavated in this area and consisted of a brown (10YR 4/3) loam between 0 and 40 cmbs underlain by a yellowish brown (10YR 5/4) silty clay loam between 40 and 80 cmbs; however, no cultural materials were recovered. A quarried area approximately 30 m from Shovel Test 21 revealed a deep soil profile exposure (Figure 6). The profile exhibited a thin A horizon that was underlain by a thick homogenous B horizon extending to approximately 4 meters below the surface until contact with Pleistocene gravels. No buried soils or cultural materials were observed in the exposed profile.

Table 1
Shovel Tests Excavated Within the Lackland Air Force Base Project Area

ST#	Soil Description	Contents
1	0-45 cmbs: (10YR 3/1) silty clay loam, 40 percent stream polished limestone gravels, slight clay increase with depth 45+ cmbs: impenetrable gravel layer	No cultural materials
2	0-80 cmbs: (10YR 3/2) silty clay loam, finely crushed snail shells, 10 percent polished limestone pebbles	No cultural materials
3	0-55 cmbs: (10YR 3/2) silty clay loam, loosely consolidated 55-80 cmbs: (10YR 3/2) silty clay loam with (10YR 5/4 mottles)	No cultural materials
4	0-80 cmbs: (10YR 4/3) silty clay loam, limestone gravels present throughout but decrease with depth	No cultural materials
5	0-50 cmbs: (10YR 2/1) compact silty clay loam, moderate limestone gravels throughout 50-80 cmbs: (10YR 3/3) very compact silty clay, few small limestone gravels	No cultural materials
6	0-80 cmbs: (10YR 3/2) very compact silty clay loam, limestone gravels and crushed snail shells throughout	No cultural materials
7	0-10 cmbs: (10YR 4/3) loam, asphalt, gravel, limestone gravels, crushed snail shells throughout 10+ cmbs: impenetrable asphalt, concrete	No cultural materials
8	0-15 cmbs: (10YR 4/3) loam, asphalt, gravel, limestone gravels, crushed snail shells throughout 15+ cmbs: impenetrable asphalt, concrete	No cultural materials
9	0-20 cmbs: (10YR 3/2) silty clay loam, abundant limestone pebbles 20-35 cmbs: (10YR 4/3) very compact friable silty loam mottled (10YR 5/4), abundant gravels and calcium carbonate threads (Bk horizon)	No cultural materials
10	0-35 cmbs: (10YR 4/3) very compact friable silty loam mottled (10YR 5/4), abundant gravels and calcium carbonate threads (Bk horizon)	No cultural materials
11	0-40 cmbs: (10YR 4/3) loam 40-45 cmbs: (10YR 4/3) very compact friable loam, many calcium carbonate threads (Bk horizon)	No cultural materials
12	0-45 cmbs: (10YR 3/2) silty clay loam, abundant limestone pebbles 45-50 cmbs: (10YR 4/3) very compact friable silty loam mottled (10YR 5/4), abundant gravels and calcium carbonate threads (Bk horizon)	No cultural materials
13	0-40 cmbs: (10YR 4/2) loam 40-50 cmbs: (10YR 4/3) very compact friable loam, abundant calcium carbonate threads (Bk horizon)	No cultural materials
14	0-40 cmbs: (10YR 4/2) loam mottled (10YR 6/4) intermixed with asphalt, limestone and concrete fragments 40+ cmbs: impenetrable gravels and asphalt	No cultural materials
15	0-10 cmbs: (10YR 4/3) loam, asphalt, gravels, and concrete fragments throughout 10+ cmbs: impenetrable asphalt, concrete	No cultural materials
16	0-10 cmbs: (10YR 3/2) loam 10+ cmbs: impenetrable concrete	No cultural materials
17	0-10 cmbs: (10YR 4/3) loam, 70 percent gravels 10+ cmbs: impenetrable gravels, limestone, and concrete fragments throughout	No cultural materials
18	0-35 cmbs: (10YR 3/2) loam, modern trash, gravel, and asphalt throughout 35-45 cmbs: (10YR 4/3) clay mottled numerous colors from mixing of fill 45+ cmbs: impenetrable concrete	No cultural materials
19	0-20 cmbs: (10YR 4/3) loam 20+ cmbs: impenetrable limestone	No cultural materials
20	0-30 cmbs: (10YR 5/3) silty loam, abundant limestone gravels 30+ cmbs: impenetrable gravel layer	No cultural materials
21	0-40 cmbs: (10YR 4/3) loam 40-80 cmbs: (10YR 5/4) silty clay loam	No cultural materials
22	0-40 cmbs: (10YR 6/4) coarse sandy loam, few limestone cobbles throughout 40+ cmbs: impenetrable limestone cobbles	No cultural materials

Table 1 (cont'd)

ST#	Soil Description	Contents
23	0-20 cmbs: (10YR 4/2) loam, highly disturbed, asphalt, limestone gravels 20+ cmbs: impenetrable gravel subsurface	No cultural materials
24	0-20 cmbs: (10YR 4/2) loam, highly disturbed, asphalt, limestone gravels 20+ cmbs: impenetrable gravel subsurface	No cultural materials
25	0-5 cmbs: (10YR 4/2) loam, asphalt and concrete throughout 5+ cmbs: impenetrable subsurface	No cultural materials
26	0-5 cmbs: (10YR 4/2) loam, asphalt and concrete throughout 5+ cmbs: impenetrable subsurface	No cultural materials
27	0-15 cmbs: (10YR 4/2) loam, limestone gravels throughout 15-20 cmbs: (10YR 5/3) clay loam, abundant gravels 20+ cmbs: impenetrable subsurface	0-20 cmbs: 4 fragments of window glass
28	0-10 cmbs: (10YR 4/2) loam, limestone gravels throughout 10-20 cmbs: (10YR 5/3) clay loam, abundant gravels 20+ cmbs: impenetrable subsurface	No cultural materials
29	0-40 cmbs: (10YR 4/3) loam 40-50 cmbs: (10YR 5/3) silty clay with abundant calcium carbonate threads (Bk horizon)	No cultural materials
30	0-45 cmbs: (10YR 4/3) loam 45-55 cmbs: (10YR 5/3) silty clay with abundant calcium carbonate threads (Bk horizon)	No cultural materials
31	0-40 cmbs: (10YR 4/3) loam 40-50 cmbs: (10YR 5/3) silty clay with abundant calcium carbonate threads (Bk horizon)	No cultural materials
32	0-25 cmbs: (10YR 4/3) loam 25-35 cmbs: (10YR 5/3) silty clay with abundant calcium carbonate threads (Bk horizon)	No cultural materials
33	0-45 cmbs: (10YR 4/3) compact loam 45-50 cmbs: (10YR 5/3) silty clay with abundant calcium carbonate threads (Bk horizon)	No cultural materials
34	0-25 cmbs: (10YR 5/3) loam 25+ cmbs:: impenetrable stony subsurface	No cultural materials
35	0-5 cmbs: (10YR 6/2) gravelly loam 5+ cmbs: impenetrable stony subsurface	No cultural materials
36	0-20 cmbs: (10YR 4/3) gravelly loam 20+ cmbs: impenetrable stony subsurface	0-20 cmbs: 2 pieces of burnt bottle glass
37	0-10 cmbs: (10YR 4/3) gravelly loam 10+ cmbs: impenetrable stony subsurface	0-10 cmbs: 6 pieces of bottle glass (2 burnt)
38	0-10 cmbs: (10YR 4/3) gravelly loam 10+ cmbs: impenetrable stony subsurface	No cultural materials
39	0-10 cmbs: (10YR 4/3) gravelly loam 10+ cmbs: impenetrable stony subsurface	No cultural materials

The northernmost meander of Leon Creek was then crossed and the route between the two meanders was traversed. Again, sequential rows of spoil piles were encountered throughout this area and were found south of the southernmost stream meander as well (Figure 7). In addition, numerous large quarry pits were observed (Figure 8), which over time have filled in with sediment as water from the surrounding higher ground drains directly into the pits. It is clear that quarrying has compromised the integrity of the deposits adjacent to Leon Creek within this particular region. Several shovel tests were attempted within these areas (Shovel Tests 22, 34-35), but each was terminated due to contact with dense gravels. These gravels are similar in composition to the Pleistocene gravels observed at the base of the quarry exposure described above, suggesting that Holocene alluvium was significantly disturbed or removed all together during the quarrying process. This evidence minimized the amount of shovel tests excavated near Leon Creek and also precluded the need for deep backhoe trenching.

Figure 5. Asphalt parking lot/road in open grassy area once used as a landfill, looking south.

Figure 6. Four-meter deep soil profile in quarry exposure, looking south.

Figure 7. Rows of push piles observed throughout the Leon Creek floodplain, looking west.

Figure 8. One of numerous borrow pits observed throughout the Leon Creek floodplain, looking east.

PROPOSED ACTION

The archaeological survey was continued along the Proposed Action ROW at the Proposed Action Guard Shack location (see Figure 2). This area consists primarily of sparsely populated mesquite trees with minimal understory vegetation and prairie grasses within the open areas. It is situated on a nearly level stream terrace that formed in loamy alluvium. Ground surface visibility was approximately 10-20 percent. Six shovel tests (1-6) were excavated evenly throughout the proposed guard shack location as no high probability landforms which would require concentrated efforts were identified during the walkover. In most cases, a very dark grayish brown (10YR 3/2) to dark grayish brown (10YR 4/3) silty clay loam extended from the surface to 80 cmbs and contained stream polished limestone gravels ranging from 10-40 percent in volumetric density. Shovel Test 1 was actually terminated at 45 cmbs as the gravel layer became impenetrable (Figure 9). While the soils encountered within the Proposed Action Guard Shack location seem to retain fair integrity, several push piles of disturbed sediment and asphalt were observed within this area (Figure 10) indicating that some level of disturbance has occurred. According to soil maps (see Figure 3) and the 1963 aerial map (see Figure 4), quarrying has occurred in the areas surrounding this guard shack location and may explain the disturbances observed. No cultural materials were encountered in this area.

Figure 9. Shovel Test 1 profile with scale.

Figure 10. Asphalt push piles adjacent to the APE, looking east.

Shovel testing was resumed to the north where the Proposed Action parallels and partially overlaps the existing Growdon Road. It was immediately apparent that construction activities have impacted the deposits within this area. Asphalt and gravels were encountered in Shovel Tests 7 and 8 preventing excavation beyond 15 cmbs. Following this, the remnants of an asphalt road were observed immediately to the west of the existing Growdon Road (see Figure 2). Where the road has collapsed, a clear soil profile was observed and photographed (Figure 11). Directly below the road, a brown (10YR 4/3) loam with abundant calcium carbonate threads was observed. This horizon is consistent with the Bk horizon subsoil mapped in the Sunev clay loam soil series and its position directly below the road indicates that the upper A horizon was significantly disturbed or removed altogether during construction of the road. No cultural materials or buried soils were observed in the exposed profile, and due to the apparent disturbances, the potential for intact archaeological deposits within this area is considered to be low. Progressing to the south as the proposed route begins to turn gradually to the southwest, shovel tests (10-13) began to encounter more intact soils. The same Bk horizon subsoil that was observed below the road in the above description was encountered at approximately 40 cmbs below a brown (10YR 4/3) loam A horizon. Shovel tests were terminated upon contact with the sterile subsoil and no cultural materials were encountered.

Progressing to the south of Shovel Test 13, the area began to again show signs of modern construction activities. An asphalt parking lot and several push piles were encountered just south of Shovel Test 13 (Figure 12) and modern trash piles were also observed adjacent to the parking lot. The asphalt lot appears to be relatively recent and no additional work was required in this area. To the south of this, the route then overlaps with the northwest corner of a fenced property

Figure 11. Soil profile exposed under collapsed roadway west of Growdon Road, looking east.

Figure 12. Remnants of an asphalt parking lot/road west of Growdon Road, looking west.

containing horses and construction equipment (see Figure 2). The area surrounding this property within the ROW appears to have been used for dumping and the presence of additional push piles suggested that the subsurface may have been disturbed as well. To determine if this was the case, Shovel Tests 14 and 15 were excavated and each was terminated early due to contact with asphalt, concrete, and limestone gravels (Figure 13). In sum, the potential for intact cultural archaeological materials within the area east of Leon Creek and west of Growdon Road is very low.

Figure 13. Shovel Test 15 profile with scale.

Southwest of the Proposed Action Guard Shack location described above, the Proposed Action passes through an impoundment lot (Figure 14) and then through an active quarrying staging area (Figure 15). The location of the Alternative 2 Guard Shack location overlaps almost entirely with the quarrying staging area (see Figure 2). These areas have clearly been significantly impacted by construction activities, and aside from photodocumentation, no archaeological work was necessary there. The southernmost segment of the project area is immediately south of the quarrying staging area and Morey Road where Alternatives 1 and 2 converge with the Proposed Action. The area consists of a recently plowed agricultural field with very good ground surface exposure (Figure 16). The property owner did not allow subsurface testing on this property. As a result, the field was walked over at 10-m intervals to inspect the ground surface for archaeological materials; however, none were encountered. Numerous chert cobbles were noted during the walkover, but all were determined to represent natural cobbles.

Figure 14. Impoundment lot southwest of Gate Option 1, looking north.

Figure 15. Active quarrying north of Morey Road, looking north.

Figure 16. Plowed agricultural field south of Morey Road, looking south.

The remaining portion of the Proposed Action extends from Highway US 90 and continues east to Growdon Road. As the route turns east from the open lot, it enters into a secondary hardwood forest. Surface visibility was less than 10 percent, but it was obvious that the area was highly disturbed. Extensive areas were scattered with large concrete chunks (Figure 17) and sequential rows of push piles containing fragments of asphalt (Figure 18). Shovel Tests 23-26 confirmed that these impacts are widespread and extend into the subsurface as each of these shovel tests encountered concrete fragments and gravels and were terminated at 20 cmbs or shallower.

Progressing to the east, remnants of a historic structure, designated site 41BX1886, was encountered immediately south of the Peerless Equipment Company (Figures 19 and 20). The razed structure is divided into two sections by a concrete pathway and a dual-step porch (Figure 21). East of the walkway, the area appears to have been used as an outbuilding, while an enclosed wooden fence west of the walkway indicates that the western portion was likely used as a small stable area.

The earliest topographic map to show structures in this vicinity is the 1953 West San Antonio topographic quad which depicts a road system connecting this structure along with several other structures within and south of the Proposed Action ROW (Figure 22; see Figure 4). According to the 1963 aerial image this road system appears to have extended south into the interior of the Leon Creek meander and may have been used to access a construction staging area which is also visible on the 1963 image (see Figure 4). The area immediately south of the collapsed structure was inspected for the presence of the additional mapped structures; however, none was encountered in primary context. Instead, structure remnants were found piled along a steep ridge

Figure 17. Scattered concrete boulders in wooded area of Alternative Route 2, looking north.

Figure 18. Sequential push piles of asphalt, looking northwest.

Figure 19. Remnants of collapsed structure at 41BX1886, looking south.

to the south above the Leon Creek floodplain (Figures 23 and 24). The materials mixed within the rubble consist primarily of large concrete slabs and corrugated metal, although numerous domestic items such as glass bottles, aluminum cans, tin wash pales, tin cans, and other household items were also observed. The majority of the aluminum cans found across the site exhibited a pull-tab opening, and according to approximate initial production dates of pull tabs, one can of Schlitz beer can be dated to as early as 1963 (Figure 25).

According to the time series presented in Figure 22, the area where the structures are mapped appears to have been impacted by construction activities sometime between 1963 and 1966, although the type of construction and degree to which it impacted the structures is unclear from the aerial photographs. A metal pesticide container observed on the ground surface adjacent to the collapsed structure was produced by Transvaal, Inc. of Jacksonville, Arkansas sometime between 1971 and 1976 suggesting that the structures were not destroyed between 1963 and 1966 and may have been used into the 1970s. However, it is also possible that the structures were demolished at some point between 1963 and 1966 and the pesticide container was deposited on the ground surface at a later date. Together, the artifacts observed, in addition to the historic topographic and aerial maps reviewed, suggest that the area represents a demolished, mid-twentieth century homestead site that may have been used into the 1970s. No other time-diagnostic items or historic imagery was found that would suggest that the site was occupied prior to the mid-twentieth century.

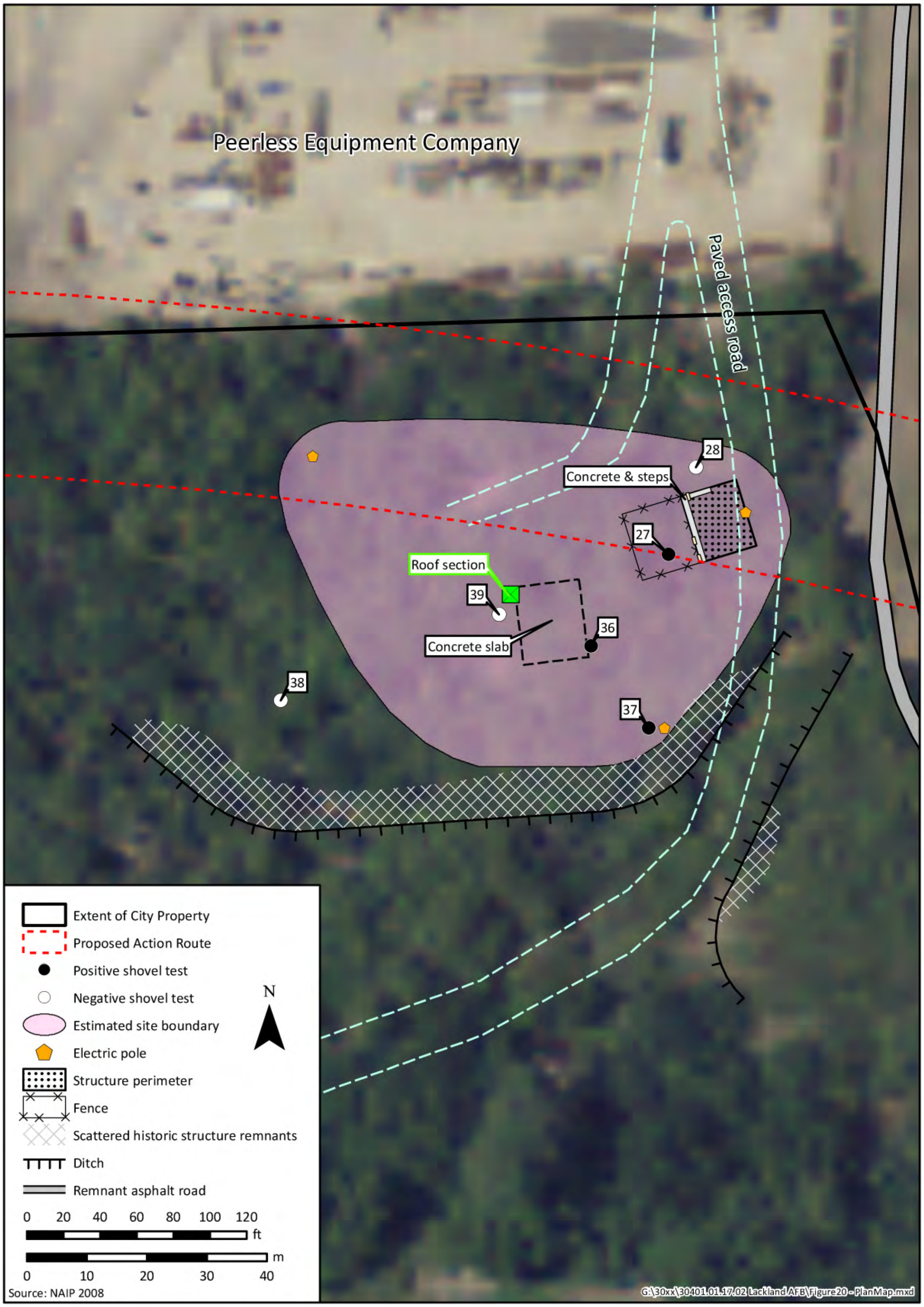

Figure 20. Plan map of site 41BX1886

Figure 21. Dual-step concrete porch at western edge of collapsed structure, looking down.

Six shovel tests were excavated adjacent to the mapped structures to search for subsurface deposits (see Table 1). Only three of the six shovel tests (Shovel Tests 27, 36, and 37) yielded cultural materials consisting of window glass and bottle glass fragments, several of which were burned. The soils encountered during shovel testing consisted of a dark grayish brown (10YR 4/2) or brown (10YR 4/3) gravelly loam. The shovel tests were terminated between 5 and 20 cmbs due to contact with extremely dense gravels. The shallow soils and encounter with dense gravels indicates the integrity of the deposits within the site boundary have been negatively impacted by construction activities.

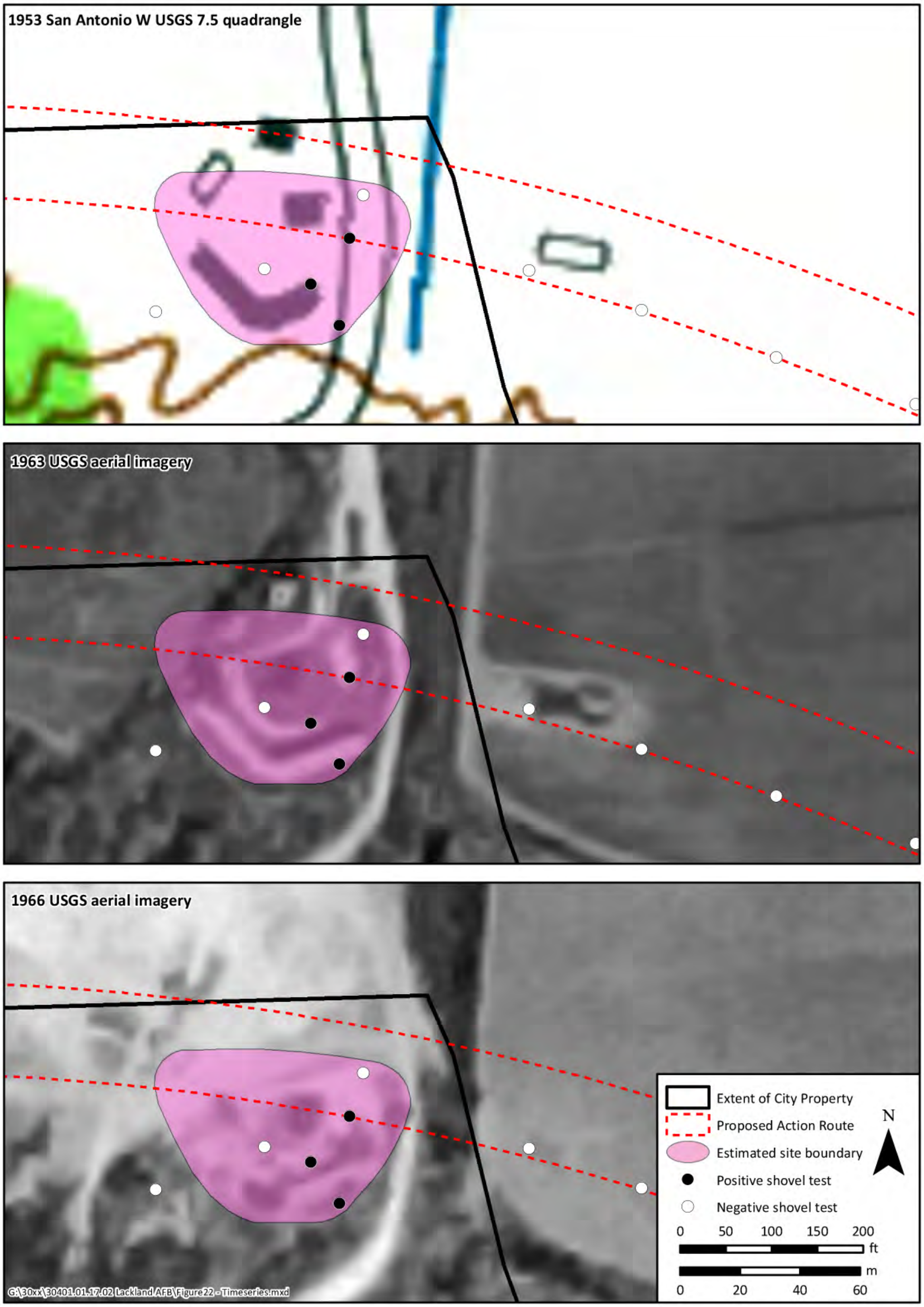

Figure 22. Time series of site 41BX1886 at Lackland AFB.

Figure 23. Historic structure remnants pushed along ridge, looking down.

Figure 24. Historic structure remnants pushed along ridge, looking down.

Figure 25. Post-1963 Schlitz pull tab beer can, looking down.

CHAPTER 6
RECOMMENDATIONS

The intensive archaeological survey conducted for the proposed relocation of Growdon Gate at Lackland AFB in San Antonio, Bexar County, Texas resulted in the excavation of 39 shovel tests and the documentation of 41BX1886, a mid-twentieth-century homestead site, within and adjacent to the Proposed Action ROW. Site 41BX1886 has been adversely affected by demolition and ground-disturbing activities associated with modern development adjacent to Lackland AFB. The majority of the artifact assemblage associated with this site is out of primary context and consists of items typical of mid-twentieth-century refuse. Given the minimal information potential associated with this site and lack of integrity, it is unlikely that it will provide any additional information relevant to understanding community and regional development in Bexar County during the mid-twentieth century. Thus, site 41BX1886 is recommended as ineligible for inclusion in the NRHP or for designation as a SAL.

The vast majority of the project area was found to be in a disturbed context resulting from numerous modern construction activities associated with Lackland AFB and the City of San Antonio. As a result, the contextual integrity of deposits within the project area has been significantly compromised. Aside from 41BX1886, no archaeological materials were encountered in the project area. Therefore, based on the results of this cultural resources survey, there is low potential for deposits containing archaeological materials within the current or proposed ROW. In accordance with 36 CFR 800.4(d)(2) and 13 TAC 26.2, no further investigation is necessary. Consequently, it is recommended that construction be allowed to proceed. If archaeological deposits are encountered during construction, work should cease and the Texas Historical Commission should be notified.

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Appendix E

SHPO/City of San Antonio Correspondence

GMI
A Subsidiary of Applied Research Associates, Inc.
2201 K Avenue, Suite A2, Plano, Texas 75074-5977 ph: 972.423.5480 fax: 972.422.2736
www.geo-marine.com

26 July 2011

Mr. Mark Denton
Department of Antiquities Protection
Texas Historical Commission
108 W. 16th Street
Austin, Texas 78701

SUBJECT: Request Review and Concurrence on *Cultural Resources Survey for the Relocation of Growdon gate at Lackland Air Force Base, Bexar County, Texas* (Texas Antiquities Permit Number 5941)

Dear Mr. Denton:

Geo-Marine, Inc. is submitting the enclosed report on behalf of Weston Solutions, Inc. and Lackland Air Force Base for review and concurrence. The report presents the results of archeological survey of 3.39 mi of right-of-way for the proposed relocation of Growdon Road, Growdon Gate, and the Commercial Vehicle Inspection Area at Lackland Air Force Base. The survey was conducted under Antiquities Permit No. 5941.

One newly recorded archeological site, 41BX1886, was identified during the project. This is a mid-twentieth-century homestead that was apparently demolished during urban expansion adjacent to Lackland Air Force Base and Kelly Air Force Base. Given the minimal information potential associated with this site and lack of integrity due to extensive razing of the historic structures, it is unlikely that it will provide any additional information relevant to understanding community and regional development in Bexar County during the mid-twentieth century. Thus, site 41BX1886 is recommended as ineligible for inclusion in the National Register of Historic Places or for designation as a State Archaeological Landmark.

The vast majority of the project area was found to be in a disturbed context resulting from numerous modern construction activities associated with Lackland Air Force Base and the City of San Antonio. As a result, the contextual integrity of deposits within the project area has been significantly compromised. Aside from 41BX1886, no archaeological materials were encountered in the project area during shovel testing. It is our recommendation that the proposed action proceed without additional cultural resources investigations.

If you have any questions or concerns, please do not hesitate to call me at (972) 423-5480.

Sincerely,

Ben Fullerton
Project Archaeologist, Cultural Resources Division

Enclosure
Reference # 30401.01.17.02

CONCUR

by________________________
for Mark Wolfe
State Historic Preservation Officer
Date________________________

TEXAS HISTORICAL COMMISSION

real places telling real stories

August 24, 2011

Ben Fullerton
Geo-Marine Inc.
2201 K. Ave., Suite A2
Plano, TX 75074-5977

Re: Project review under the Antiquities Code of Texas, Antiquities Permit #5941, Growdon Road and Growdon Gate Relocation Survey, Draft Report (USAF/City of San Antonio)

Dear Mr. Fullerton:

Thank you for your correspondence concerning the above referenced project. This letter presents the comments of the Executive Director of the Texas Historical Commission (THC), the state agency responsible for administering the Antiquities Code of Texas and National Historic Preservation Act.

We have completed our review of the Draft Report for Antiquities Permit #5941, and we concur that site 41BX1886 is not eligible for inclusion in the National Register of Historic Places, or worthy of official State Archeological Landmark designation.

With regard to the recommendation that no further investigations are warranted in association with the areas surveyed under Permit #5941, the THC concurs with the understanding that if the Air Force considers any alternatives not presented in the report or alters the Area of Potential Effect those options must be reviewed in consultation with the THC and the City Preservation Office, if their lands are used. Further, other construction effects at Lackland Air Force Base will require Section 106 consultation. Please also insure that all archeological reports associated with City of San Antonio property are reviewed by the City Archeologist, including this report.

Thank you for your cooperation in this state review process, and for your efforts to preserve the irreplaceable heritage of Texas. We will await receipt of the final copy of the report with any comments you may get from the City Archeologist, two tagged PDF format copies of the report on an archival quality CD or DVD, and a completed copy of the THC Abstract in Texas Archeology Form, and a signed copy of the THC Curation Form. **If you have any questions please contact our lead reviewer, Mark H. Denton, at (512) 463-5711.**

Sincerely,

Mark H. Denton

for
Mark Wolfe
Executive Director

cc: Kay Hindes (City Preservation Office)

GMI
A Subsidiary of Applied Research Associates, Inc.
2201 K Avenue, Suite A2, Plano, Texas 75074-5977 ph: 972.423.5480 fax: 972.422.2736
www.geo-marine.com

30 August 2011

Ms. Kay Hindes
Office of Historic Preservation
City of San Antonio
1901 S. Alamo
San Antonio, TX 78283

SUBJECT: Request Review and Concurrence on *Cultural Resources Survey for the Relocation of Growdon Gate at Lackland Air Force Base, Bexar County, Texas* (Texas Antiquities Permit Number 5941)

Dear Ms. Hindes:

Geo-Marine, Inc. is submitting the enclosed report on behalf of Weston Solutions, Inc. for review and concurrence. We have received concurrence from the THC and also request concurrence from the City Preservation Office as the report is associated with the City of San Antonio property. The report presents the results of archaeological survey of 3.39 mi of right-of-way for the proposed relocation of Growdon Road, Growdon Gate, and the Commercial Vehicle Inspection Area at Lackland Air Force Base. The survey was conducted under Antiquities Permit No. 5941.

One newly recorded archeological site, 41BX1886, was identified during the project. This is a mid-twentieth-century homestead that was apparently demolished during urban expansion adjacent to Lackland Air Force Base and Kelly Air Force Base. Given the minimal information potential associated with this site and lack of integrity due to extensive razing of the historic structures, it is unlikely that it will provide any additional information relevant to understanding community and regional development in Bexar County during the mid-twentieth century. Thus, site 41BX1886 is recommended as ineligible for inclusion in the National Register of Historic Places or for designation as a State Archaeological Landmark.

The vast majority of the project area was found to be in a disturbed context resulting from numerous modern construction activities associated with Lackland Air Force Base and the City of San Antonio. As a result, the contextual integrity of deposits within the project area has been significantly compromised. Aside from 41BX1886, no archaeological materials were encountered in the project area during shovel testing. It is our recommendation that the proposed action proceed without additional cultural resources investigations.

If you have any questions or concerns, please do not hesitate to call me at (972) 423-5480.

Sincerely,

Ben Fullerton
Project Archaeologist, Cultural Resources Division

CONCUR

by____________________
for Kay Hindes
City Archaeologist

Date____________________

Enclosure
Reference # 30401.01.17.02

Duane Peter

From: Kay Hindes [Kay.Hindes@sanantonio.gov]
Sent: Friday, October 14, 2011 12:46 PM
To: Duane Peter
Subject: Re: Review of Lackland AFB report

Duane:

Yes, I have no edits or comments.

Sent from my iPhone

On Oct 13, 2011, at 8:44 PM, "Duane Peter" <dpeter@geo-marine.com> wrote:

> Kay: our client is eager for us to complete the report; have you had a chance to review?
>
> Thank you,
>
> Sent from my iPhone

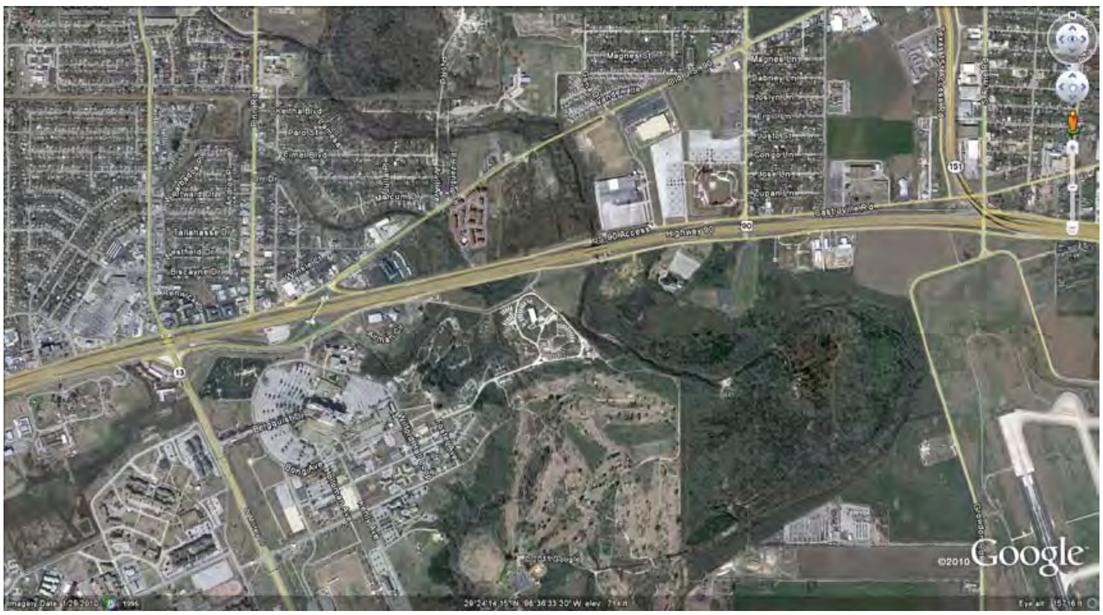
Appendix F

Lackland Air Force Base Traffic Study – Commercial Vehicle Relocation Transportation Impact Study

Final Report

Lackland Air Force Base Traffic Study

Commercial Vehicle Relocation Transportation Impact Study



Prepared for: Weston Solutions, Inc.

Prepared by:

APPLIED RESEARCH ASSOCIATES, INC. and VISION ENGINEERING & PLANNING

TABLE OF CONTENTS

Traffic Impact Analysis Glossary

Access Point = An intersection, driveway, or opening on a public street providing entry to a private development or property.
ADA= Americans with Disabilities Act
Adjacent Street Traffic= All traffic with direct access to a development site
Arterial= A signalized street that primarily serves through traffic and that secondarily provides access to abutting properties, with signal spacing of 2.0 miles or less.
At-Grade Intersection = The location at which two roadways cross and join at the same vertical elevation; access through the intersection may be controlled by traffic signals or stop/yield signs
Background Conditions = Conditions affecting the performance of the transportation network not directly related to the subject development over a designated time period, such as growth in existing traffic volumes, other planned, approved or current developments in the study area, and planned improvements to the transportation network
Capacity = The maximum sustainable flow rate at which vehicles or persons reasonably can be expected to traverse a point or uniform segment of roadway during a specified time period under given roadway, geometric, traffic, environmental, and control conditions, usually expressed as vehicles per hour.
Collector = A roadway with no control of access linking residential communities with the arterial system
Cycle= The time period required for one complete sequence of traffic signal indications
Delay = The additional time in seconds experienced by a roadway user, typically motorists as a result of constrained movements and deviation from ideal or free flow speeds
Generator = a land use that attracts vehicle, pedestrian, or other modes of traffic
Highway Capacity Manual = A publication of the National Academy of Sciences Transportation Research Board that provides a collection of the state-of-the-art techniques for estimating the capacity and determining the level of service for transportation facilities; first published in the 1950s and most recently published in 2010.
Internally Captured Trip= A trip originating and destined for different land uses within the same development but not traveling on a public street
Level of Service (LOS) = A qualitative measure describing operational conditions within a traffic stream, based on service measures such as speed, travel time, freedom to maneuver, traffic interruption, comfort and convenience.
Modal Split = The percentage of people using a particular means of transport, such as auto, transit, or walking, to make a trip
Multi-modal= A transportation facility for different types of users, modes, or vehicles.
Pass-by Trip = An intermediate stop on the way from an origin to a primary trip destination without a route diversion. Pass-by trips are attracted from traffic passing the site on an adjacent street or roadway that offers direct access to the development.
Peak Hour = The one-hour period of greatest utilization of a transportation facility; weekdays normally have two peaks, one in the morning and one in the afternoon
Phase= A portion of a traffic signal cycle allocated to any traffic movement or combination of traffic movements
Split-Phased Mode= A type of signal control where all movements from one side street at a time move concurrently
Trip/Trip End= A single or one-direction movement by any mode of travel with the origin or destination (exiting or entering) inside the study development.
Total Trips= The total of all trips entering plus all trips exiting during a designated time.

I. Introduction

Lackland Air Force Base is located in San Antonio, TX south of US 90 and east of Military Drive. The base is currently evaluating the relocation of the Commercial Vehicle Inspection Area which required a traffic impact assessment to evaluate the proposed impacts on the local roadway system around the Growdon Gate entrance.

This study assesses the impacts of traffic associated with the proposed relocation on the surrounding roadway network and determines what, if any, improvements are required to mitigate adverse impacts caused by the proposed relocation. This report is provided in support of the Environmental Assessment (EA). The Air Force is currently evaluating relocation of the Growdon Gate, the Commercial Vehicle Inspection Area, and Growdon Road farther west such that Growdon Road runs parallel to Leon Creek and connects with US Highway 90 at Callaghan Road to the north.

The report is divided in three sections; first the existing conditions are evaluated and documented including the existing roadway network, existing traffic volumes, and existing intersection capacity and level of service. Secondly, the future conditions are evaluated with the relocated Growdon Road and Commercial Vehicle Inspection Area, including the total future traffic volumes, and future intersection capacity and Level of Service (LOS). Lastly, the findings and recommendations are summarized at the end of the report.

II. Existing Conditions

A. Study Area Roadways, Intersections and Public Transportation

Lackland Air Force Base is located on Military Drive, south of US 90 in San Antonio, TX. The study area network includes 3 intersections on Military Drive, two intersections on Callaghan Road, one intersection on S. Acme Road, two intersections on Castroville Road, and one intersection on Old US 90. **Figure 1** shows an area map detailing the study network in relation to the project site. The following intersections were included in the analysis:

1) US 90 at Callaghan Road
2) Castroville Road at Stotzer Freeway
3) Castroville Road at S. Acme Road
4) S. Acme Road at US 90
5) W. Military Drive at Luke Boulevard
6) W. Military Drive at Bergquist Drive
7) W. Military Drive at US 90
8) US 90 at Old US 90 West
9) Callaghan Road at Old US 90

Aerial photographs of the above intersections and information regarding lane configurations are included in **Appendix A**. This study and findings are based largely on the field data collection and analysis performed during the period of May 2011 through September 2011.

1) **US 90 at Callaghan Road**: This intersection is an interchange between US 90 and Callaghan Road. The intersections are located at the frontage roads from US 90 at Callaghan Road. The westbound frontage road at Callaghan Road is controlled by a three way stop sign, and the eastbound frontage road at Callaghan Road is stop controlled on the Callaghan Road approach. The US 90 frontage roads have two lanes, and Callaghan Road is a four lane roadway with two lanes in each direction. There is an exclusive left turn lane on the northbound approach of Callaghan Road at the westbound US 90 frontage road. There is a channelized right turn lane on the southbound approach of Callaghan Road at the US 90 westbound ramp.

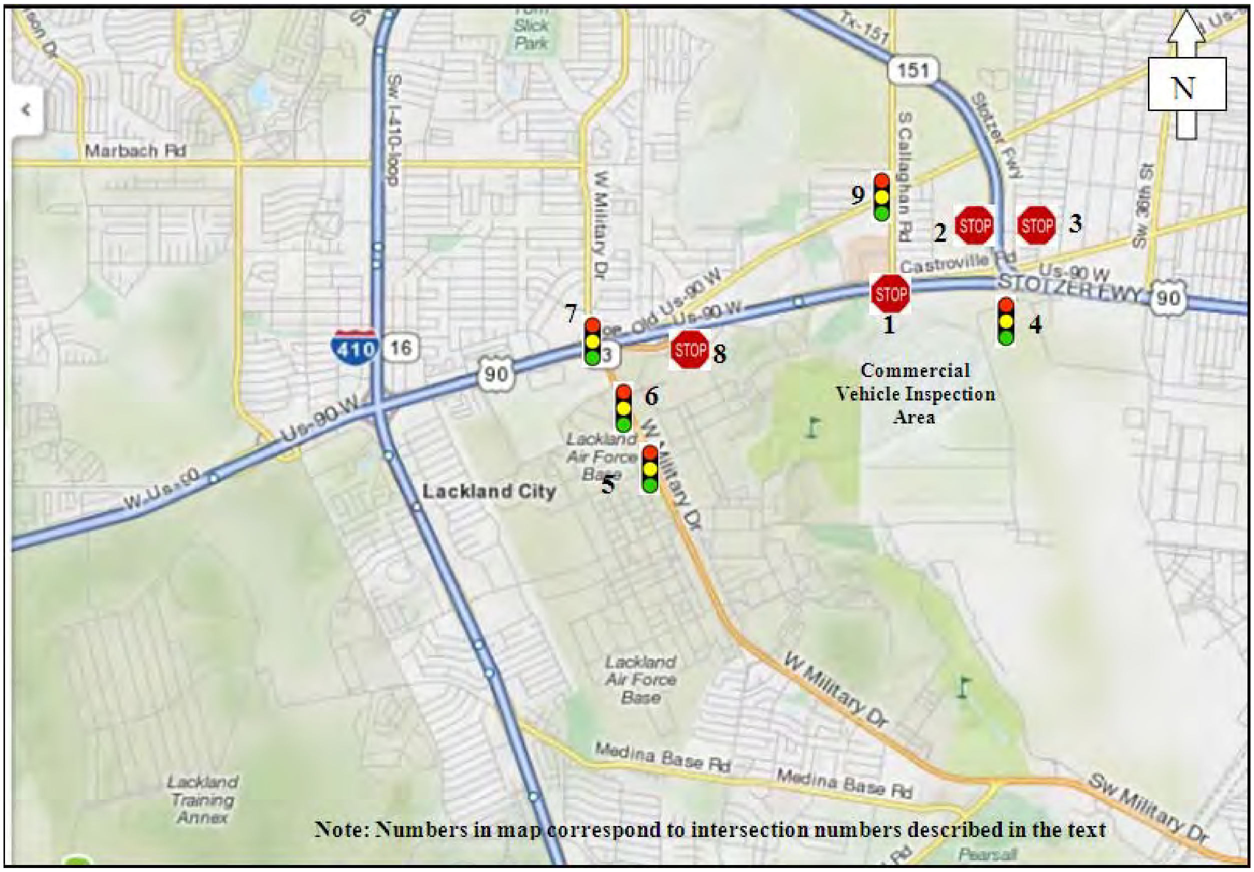


Figure 1 – Area Map (Not to Scale)

2) **Castroville Road at Stotzer Freeway**: This is a T-Intersection that is controlled by a stop sign on the Stotzer Freeway off ramp approach. Castroville Road is four lanes with two lanes in each direction. The Stotzer Freeway off ramp is two lanes with an exclusive right turn lane and an exclusive left turn lane at the intersection.

3) **Castroville Road at S. Acme Road:** This intersection is controlled by a four way stop sign. Castroville Road is four lanes with two lanes in each direction. The eastbound approach of Castroville Road has an exclusive left turn lane at the intersection. S. Acme Road is four lanes with two lanes in each direction. There are exclusive left turn lanes on both approaches of S. Acme Road.

4) **S. Acme Road at US 90:** This intersection is an interchange between US 90 and S. Acme Road. The intersections are located at the frontage roads from US 90 at S. Acme Road. The westbound frontage road at S. Acme Road is

controlled by a traffic signal, and the eastbound frontage road at S. Acme Road is controlled by a traffic signal. The US 90 frontage roads have two lanes, and S. Acme Road is a four lane roadway with two lanes in each direction. There is an exclusive left turn lane on the northbound approach of S. Acme Road at the westbound US 90 frontage road, and there is an exclusive left turn lane on the southbound approach of S. Acme Road at the eastbound US 90 frontage road. There is a channelized right turn lane and an exclusive left turn lane on the westbound US 90 frontage road.

5) **W. Military Drive at Luke Boulevard:** This intersection is controlled by a traffic signal. W. Military Drive is six lanes with three lanes in each direction. There are exclusive dual left turn lanes and exclusive right turn lanes on both approaches of W. Military Drive. Luke Boulevard is four lanes with two lanes in each direction. There are exclusive left turn lanes on both approaches of Luke Boulevard. There are security gates on Luke Boulevard east and west of the intersection.

6) **W. Military Drive at Bergquist Drive:** This intersection is a T-intersection controlled by a traffic signal. W. Military Drive is six lanes with three lanes in each direction. There are exclusive dual left turn lanes on the southbound approach of W. Military Drive, and a channelized right turn lane on the northbound approach. The southbound approach of W. Military Drive is striped to have two thru lanes at the approach and three thru lanes south of the intersection. Bergquist Drive is four lanes with two lanes in each direction. There is an exclusive left turn lane and a channelized right turn lane on the Bergquist Drive approach. There is a security gate on Bergquist Drive east of the intersection.

7) **W. Military Drive at US 90:** This intersection is an interchange between US 90 and W. Military Drive. The intersections are located at the frontage roads from US 90 at W. Military Drive. The westbound frontage road at W. Military Drive is controlled by a traffic signal, and the eastbound frontage road at W. Military Drive is controlled by a traffic signal. The US 90 frontage roads have two lanes, and W. Military Drive is a four lane roadway with two lanes in each direction north of US 90 and a six lane roadway with three lanes in each direction south of US 90. There is an exclusive left turn lane on the northbound approach of W. Military Drive at the westbound US 90 frontage road, and there is an exclusive left turn lane on the southbound approach of W. Military Drive at the eastbound US 90 frontage road. There are also share thru/left turn lanes on the northbound approach of W. Military Drive at the westbound US 90 frontage road and on the southbound approach of W. Military Drive at the eastbound US 90 frontage road. The two lane approach of the eastbound US 90 frontage road is striped as one left turn lane and one

thru lane at the intersection. The westbound US 90 frontage road has an exclusive left turn lane, a shared thru/left turn lane, a thru lane, and an exclusive right turn lane.

8) **Old US 90 at US 90**: This is a T-Intersection that is controlled by a stop sign on the off ramp from westbound US 90. The westbound US 90 off ramp is two lanes with one thru lane continuing to westbound Old US 90 (which is one way westbound west of the intersection), and one channelized right turn lane. The eastbound US 90 off ramp to Old US 90 is one lane with an exclusive left turn lane at the intersection. This approach is free flowing as is the westbound Old US 90 approach which is two lanes.

9) **Callaghan Road at Old US 90:** This intersection is controlled by a traffic signal. Callaghan Road is five lanes with two lanes in each direction and a continuous left turn lane which is striped as an exclusive left turn lane on both approaches at the intersection. Old US 90 is four lanes with two lanes in each direction. The eastbound and westbound approaches of Old US 90 have exclusive left turn lanes at the intersection. There are channelized right turn lanes on both approaches of Old US 90.

US 90 is a six lane limited access facility roadway throughout the study area that connects the western suburbs and Lackland Air Force Base to I-35 and the Central Business District (CBD). It is a major commuter corridor in San Antonio with average daily traffic of 79,000 vehicles per day east of Old US 90.

W. Military Drive is a major highway that generally parallels I-410 on the south and east side of San Antonio. It has six lanes in the study area. The average daily traffic volumes fluctuate significantly within the study area, ranging from 39,000 south of US 90 to only 11,900 south of Five Palms Road.

Existing **pedestrian facilities** are limited throughout the study area with minimal sidewalks present in the study area.

In addition, the location is served by **public transportation.** The VIA Metropolitan Transit has bus routes 550, 551, 614, and 619 that serve the W. Military Road corridor. The Kel-Lac Transit Center is located near the intersection of US 90 and W. Military Drive as shown in **Figure 2**.

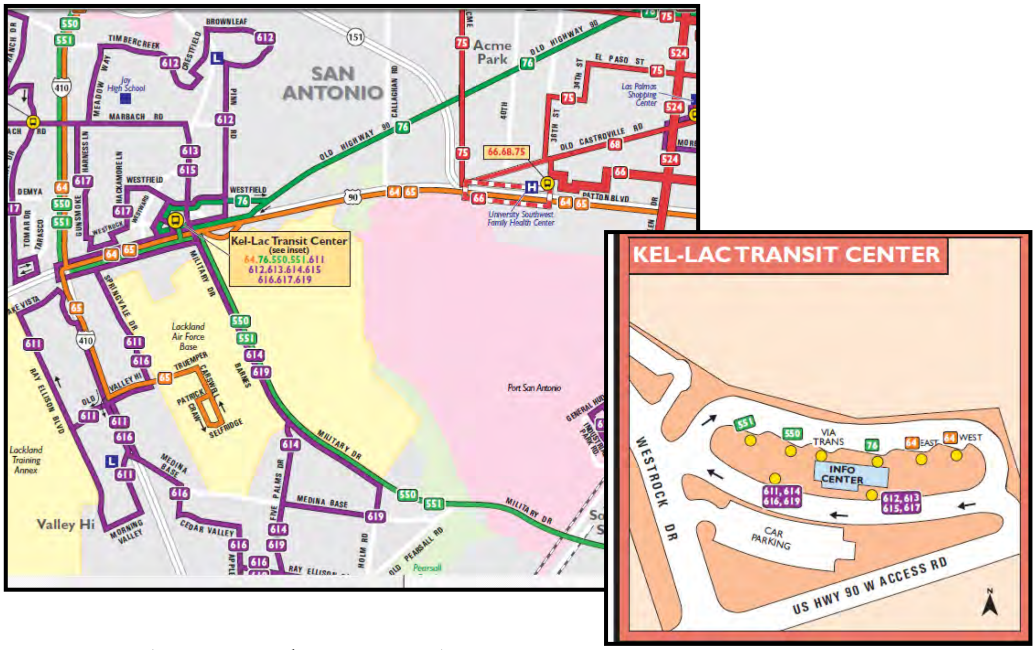


Figure 2-Kel-Lac Transit Center

B. Existing Traffic Volumes

Peak hour turning movement counts were collected primarily during May, 2011 at the study intersections from 6:00 AM to 9:00 AM and 3:00 PM to 6:00 PM. **Figures 3.1 to 3.10** summarize the existing AM peak hour traffic volumes and **Figures 4.1 to 4.10** summarize the PM peak hour traffic volumes; detailed traffic count data is included in **Appendix B.** The count data indicates that the existing peak hours occur from 7:15 AM to 8:15 AM and 4:00 PM to 5:00 PM.

Figure 3.1. AM Peak Hour - East Bound US 90 Frontage Road at S. Callaghan Road

Figure 3.2.AM Peak Hour - West Bound US 90 Frontage Road at S. Callaghan Road

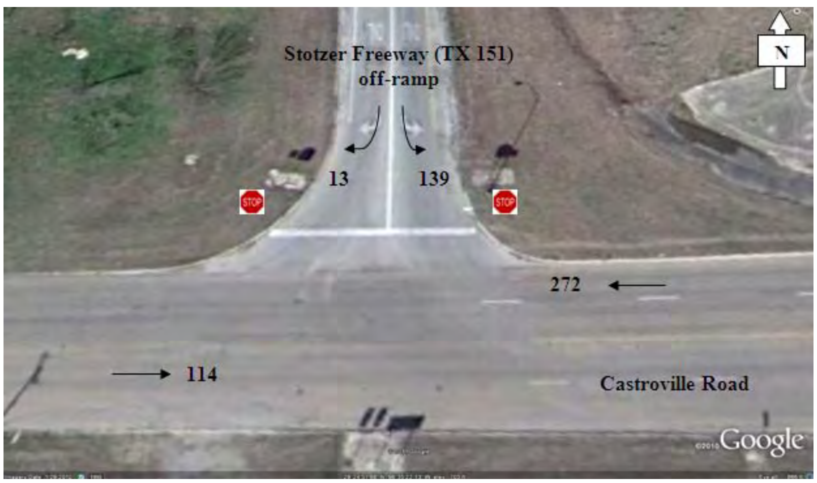


Figure 3.3. AM Peak Hour- Castroville Road at Stotzer Freeway (TX 151)

Figure 3.4. AM Peak Hour - Castroville Road at S Acme Road

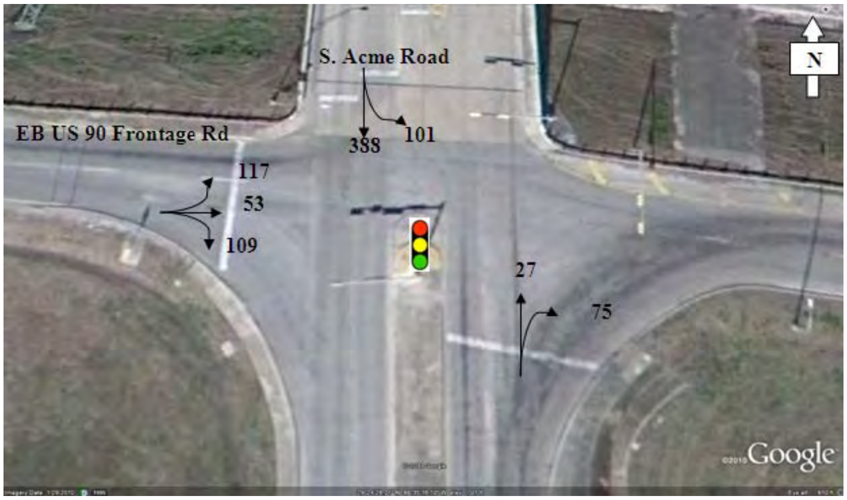


Figure3.5 AM Peak Hour - S. Acme Road at East Bound US 90 Frontage Road

Figure 3.6. AM Peak Hour - S. Acme Road at West Bound US 90 Frontage Road

Figure 3.7. AM Peak Hour - W. Military Drive at Luke Boulevard

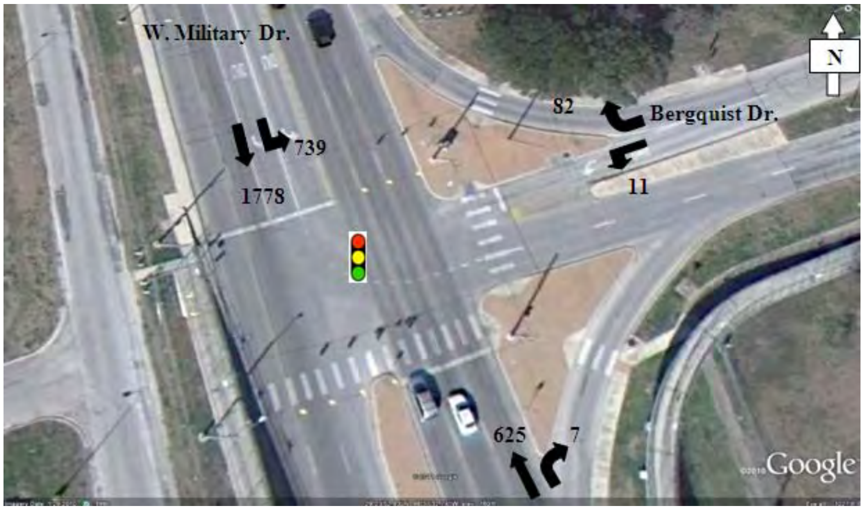


Figure 3.8.AM Peak Hour - W. Military Drive at Bergquist Drive

Figure 3.9. AM Peak Hour - W. Military Drive at East Bound US 90 Frontage Road

Figure 3.10. AM Peak Hour - W. Military Drive at West Bound US 90 Frontage Road

Figure 3.11. AM Peak Hour - Old US 90 at US 90

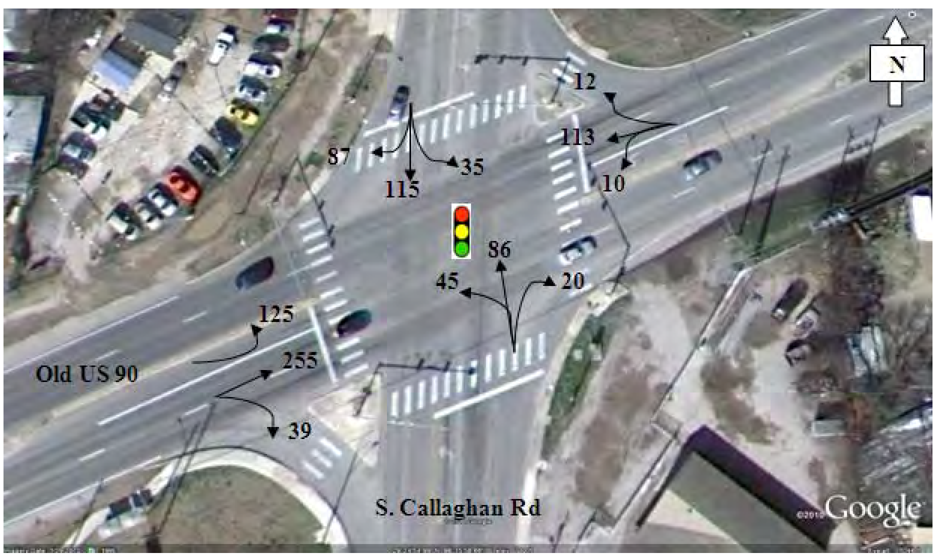


Figure 3.12. AM Peak Hour - S. Callaghan Road at Old US 90

Figure 4.1. PM Peak Hour - East Bound US 90 Frontage Road at S. Callaghan Road

Figure 4.2. PM Peak Hour - West Bound US 90 Frontage Road at S. Callaghan Road

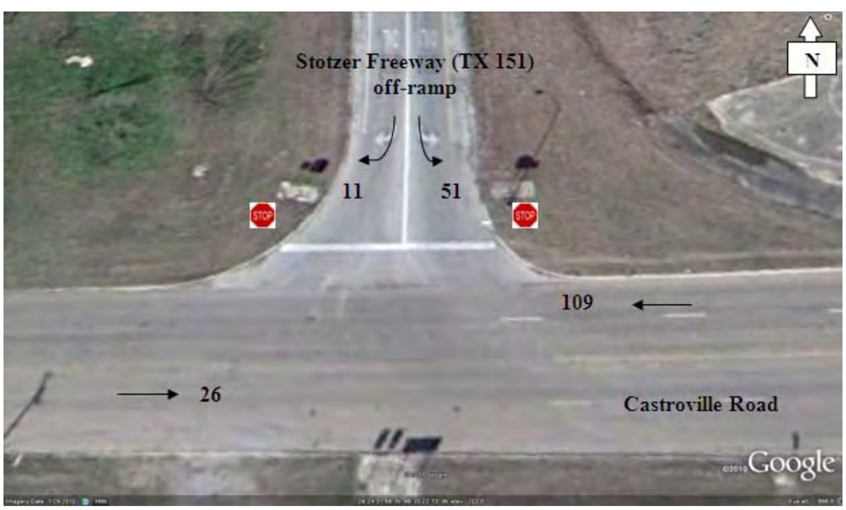


Figure 4.3. PM Peak Hour - Castroville Road at Stotzer Freeway (TX 151)

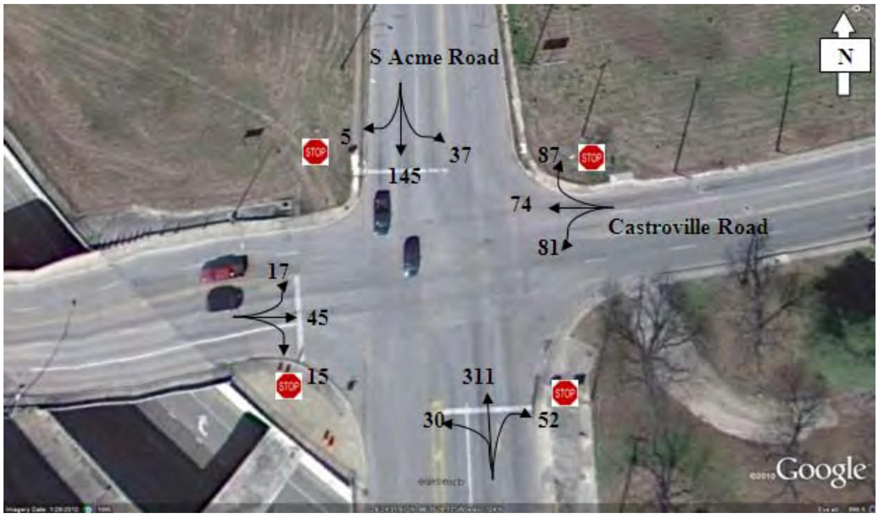


Figure 4.4. PM Peak Hour - Castroville Road at S Acme Road

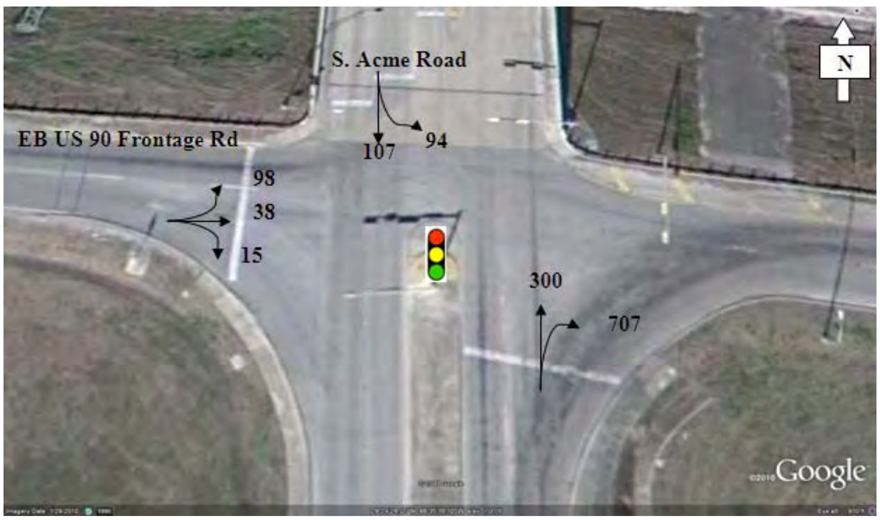


Figure 4.5. PM Peak Hour - S. Acme Road at East Bound US 90 Frontage Road

Figure 4.6. PM Peak Hour - S. Acme Road at West Bound US 90 Frontage Road

Figure 4.7. PM Peak Hour - W. Military Drive at Luke Boulevard

Figure 4.8. PM Peak Hour - W. Military Drive at Bergquist Drive

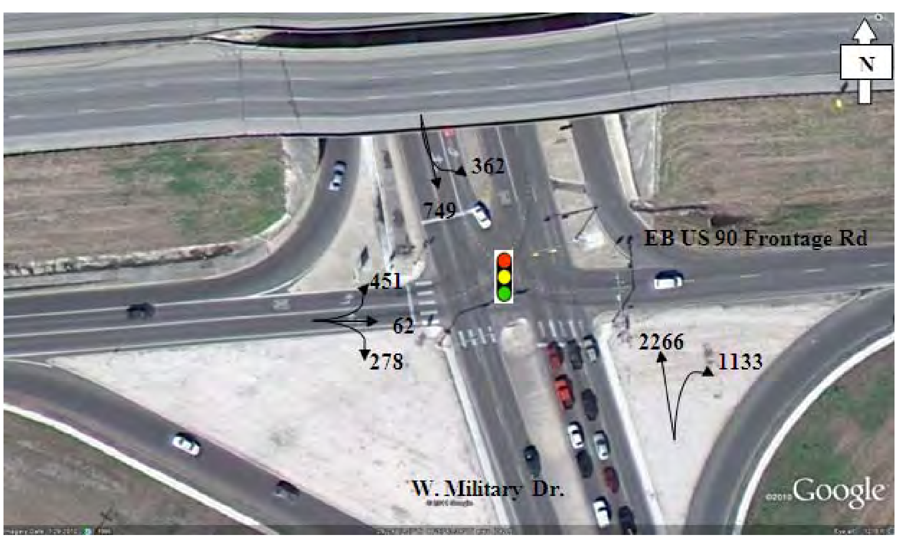


Figure 4.9. PM Peak Hour - W. Military Drive at East Bound US 90 Frontage Road

Figure 1. PM Peak Hour - W. Military Drive at West Bound US 90 Frontage Road

Figure 4.11. PM Peak Hour - Old US 90 at US 90

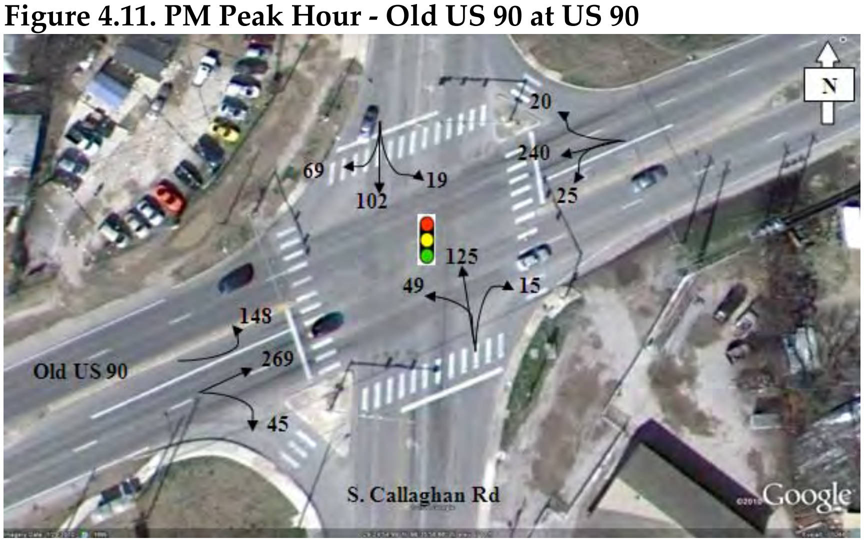


Figure 4.12. PM Peak Hour - S. Callaghan Road at Old US 90

C. Existing Intersection Capacity and Level of Service

The methodology of the Highway Capacity Manual (HCM) was used to evaluate capacity for selected intersections during the AM and PM peak hours. A Synchro traffic model was developed and coded for each peak hour with the existing conditions data including roadway geometry, traffic volumes and signal phasing data as inventoried and documented in the field. Signal timing data was requested from the City of San Antonio and Texas Department of Transportation; however timing plans have not been received to date. Therefore, optimized Synchro signal timings and cycle lengths were used in the analysis. A comparison of the Synchro LOS results to observed field conditions indicated the optimized signal timings led to results that were consistent with observed conditions in the field. Raw traffic volumes were balanced to adjust for mid-block driveways and entrances, as well as the effect of residual queues that occur during the peak hours.

Performance measures of effectiveness for HCM analysis include LOS, delay, and volume-to-capacity (v/c) ratio. The LOS is a letter designation that corresponds to a certain range of roadway operating conditions and F indicating the worst, or failing, operating condition. The v/c ratio is the ratio of the current flow rate to the capacity of the intersection. This ratio is often used to determine how sufficient capacity is on a given roadway. Generally speaking, a ratio of 1.0 indicates that the roadway is operating at capacity. A ratio of greater than 1.0 indicates that the facility is failing as the number of vehicles exceeds the roadway capacity.

The results of the existing conditions capacity analysis are summarized in the following table; detailed HCM worksheets are included in **Appendix C.**

Table 1 – Summary of Existing Capacity Analysis

Intersection	Control	AM LOS	AM Delay (sec)	PM LOS	PM Delay (sec)
Acme Road at WB US 90 Ramp	Signalized	A	9.8	B	10.3
Acme Road at EB US 90 Ramp	Signalized	A	8.1	A	8
Acme Road at Castroville Road	Unsignalized	A	0.37	A	0.37
Castroville Road at Stotzer Ramp	Unsignalized	B	14.5	A	9.7
Old US 90 at Callaghan Road	Signalized	A	8.7	A	7.5
WB US 90 Ramp at Callaghan Road	Unsignalized	A	0.23	A	0.20
EB US 90 Ramp at Callaghan Road	Unsignalized	A	0.31	A	0.26
Old US 90 at US 90 Ramp	Unsignalized	B	11.4	C	16.7

Table 1. Continued

Intersection	Control	AM LOS	AM Delay	PM LOS	PM Delay
Military Drive at WB US 90 Ramp	Signalized	E	79.1	F*	195.5
Military Drive at EB US 90 Ramp	Signalized	F*	185.3	F*	184.8
Military Drive at Bergquist Drive	Signalized	A	8	A	5.9
Military Drive at Luke Boulevard	Signalized	B	15.7	D	35.1

*LOS F represents unacceptable delay

The results of the existing conditions capacity analysis indicate that most of the study intersections currently operate at an acceptable LOS D or better during the AM and PM peak hours. The intersection of the Westbound US 90 Ramp at Military Drive is currently operating at a LOS E during the AM peak and a LOS F during the PM peak hour. The intersection of the Eastbound US 90 ramp at Military Drive is operating at a LOS F during the AM and PM peak hours. Calculations for daily traffic volumes through Growdon Gate based on the data collected show the inbound daily count was 3441 and the outbound daily count was 3611.

III. Future Conditions

The proposed alternative would relocate the Growdon Gate and the Commercial Vehicle Inspection area farther west such that Growdon Road runs parallel to Leon Creek and connects with US Highway 90 at Callaghan Road to the north.

Listed below are results of the analysis taking into consideration predictions for future traffic flows and patterns.

A. Future Conditions Intersection Capacity and Level of Service

A capacity analysis was performed for the future conditions with the results summarized in **Table 2**. Detailed HCM worksheets are included in **Appendix C.**

Table 2 – Summary of Future Conditions Intersection Capacity Analysis

Intersection	Control	AM LOS	AM Delay (sec)	PM LOS	PM Delay (sec)
Acme Road at WB US 90 Ramp	Signalized	B	12.7	B	14.1
Acme Road at EB US 90 Ramp	Signalized	B	11.4	B	17.5
Acme Road at Castroville Road	Unsignalized	A	0.55	A	0.53
Castroville Road at Stotzer Ramp	Unsignalized	E	46.5	B	11.1
Old US 90 at Callaghan Road	Signalized	B	18	B	19.5
WB US 90 Ramp at Callaghan Road	Unsignalized	A	0.41	A	0.45
EB US 90 Ramp at Callaghan Road	Unsignalized	A	0.41	A	0.45
Old US 90 at US 90 Ramp	Unsignalized	B	12	D	29.5
Military Drive at WB US 90 Ramp	Signalized	F*	272.1	F*	167
Military Drive at EB US 90 Ramp	Signalized	F*	400.1	F*	210.9
Military Drive at Bergquist Drive	Signalized	B	15.9	B	17.5
Military Drive at Luke Boulevard	Signalized	C	22	E	70.5

*LOS F represents unacceptable delay

The results of the future conditions analysis indicate that the intersection of Castroville Road at the Stotzer freeway off ramp would operate at a LOS E during the AM peak hour. The intersection of the westbound US 90 frontage road at Military Drive would operate at a LOS F during the AM and PM peak hours. The intersection of the eastbound US 90 frontage road at Military Drive would also operate at a LOS F during the AM and PM peak hours. The intersection of Military Drive at Luke Boulevard would operate at a LOS E during the PM peak hour.

IV. Findings and Recommendations

The findings of the report demonstrate that there will be increased traffic congestion in the future year scenario. Specifically, the intersections at the US 90 frontage roads at Military Drive would operate at a LOS F during the AM and PM peak hours which is comparable to existing conditions, though with significant increases in delay at the intersections. The intersection of Castroville Road at the Stotzer freeway off ramp would operate at a LOS E during the AM peak hour. The intersection of Military Drive at Luke Boulevard would operate at LOS E during the PM peak hour. In order to improve the LOS to an acceptable level D, the following improvements are recommended:

Conduct a traffic signal warrant assessment at the intersection of Castroville Road at the Stotzer Freeway off ramp in the future as traffic volumes increase. The unacceptable LOS for this intersection is associated with the delay on the stop controlled approach of the off ramp. If a signal is not installed at this location when warranted, it is possible for traffic to queue from the off ramp to the Stotzer Freeway, leading to increased risks of crashes and unsafe conditions on the freeway. A traffic signal can be timed to ensure minimal queuing on the off ramp in the future.

Construct a free right turn lane on the westbound approach of Luke Boulevard at Military Drive. A free right turn would accommodate the heavy right turn volume forecast on this approach. An additional site visit was conducted to verify that this improvement was feasible from a constructability standpoint. The site visit indicated that there is currently a short acceleration lane on Military Drive north of the intersection that could be utilized to accommodate the free right turn. Moreover, there is sufficient right of way available to extend the existing acceleration lane as necessary to accommodate merging vehicles in the future. This improvement would improve the LOS to C during the PM peak hour.

The US 90 at Military Drive intersections are currently experiencing unacceptable and failing LOS and would experience significant congestion in the future without improvements. It is recommended that an acceleration lane be constructed on the US 90 eastbound frontage east of Military Drive so that the existing channelized right turn lane can be restriped and signed as a free right turn lane. It is recommended that the frontage roads be improved to accommodate dual left turn lanes, an exclusive thru lane and exclusive right turn lane. The southbound approach of Military Drive at the eastbound US 90 frontage road, and the northbound approach of Military Drive at the westbound US 90 frontage road are recommended to be improved to accommodate dual left turn lanes and two thru lanes. These improvements would not improve the LOS to D; however these improvements would reduce the delay at the intersections to levels comparable to existing conditions. The improvements to Military Drive, in particular would require a complete reconstruction of the interchange which would require full coordination with the City of San Antonio and TxDOT. However; it is important to note that the relocated commercial vehicle facility contributes very little to the overall forecast traffic volumes, therefore these improvement would be required independent of the location of the commercial vehicle facility. Given the US 90 at Military Drive interchange is the primary gateway to Lackland Air Force Base, it is important to maintain mobility at this interchange in the future.

While this study focused on intersections in proximity to the base, it is recommended that a detailed queuing study be conducted for the gates on Luke Boulevard and Bergquist Drive. Field observations indicated queuing conditions at the security gates that would increase in the future as traffic volumes grow. These queues have the potential to impact the intersections on Military Drive without improvements to the gates and/or security clearance procedures. This situation would only be exacerbated with increased truck traffic as these vehicles are much longer than passenger cars and take longer to accelerate from a stopped condition.

Appendix A - Intersection Aerials and Lane Configurations

US 90 at Callaghan Road: This intersection is an interchange between US 90 and Callaghan Road. The intersections are located at the frontage roads from US 90 at Callaghan Road. The westbound frontage road at Callaghan Road is controlled by a three way stop sign, and the eastbound frontage road at Callaghan Road is stop controlled on the Callaghan Road approach. The US 90 frontage roads have two lanes, and Callaghan Road is a four lane roadway with two lanes in each direction. There is an exclusive left turn lane on the northbound approach of Callaghan Road at the westbound US 90 frontage road. There is a channelized right turn lane on the southbound approach of Callaghan Road at the US 90 westbound ramp. Aerial photographs of these intersections are shown in Figure A1 and Figure A2.

Figure A1. East Bound US 90 Frontage Road at S. Callaghan Road

Figure A2. West Bound US 90 Frontage Road at S. Callaghan Road

Castroville Road at Stotzer Freeway: This is a T-Intersection that is controlled by a stop sign on the Stotzer Freeway off ramp approach. Castroville Road is four lanes with two lanes in each direction. The Stotzer Freeway off ramp is two lanes with an exclusive right turn lane and an exclusive left turn lane at the intersection. An aerial photograph of this intersection is shown in Figure A3.

Figure A3. Castroville Road at Stotzer Freeway (TX 151)

Castroville Road at S. Acme Road: This intersection is controlled by a four way stop sign. Castroville Road is four lanes with two lanes in each direction. The eastbound approach of Castroville Road has an exclusive left turn lane at the intersection. S. Acme Road is four lanes with two lanes in each direction. There are exclusive left turn lanes on both approaches of S. Acme Road. An aerial photograph of this intersection is shown in Figure A4.

Figure A4. Castroville Road at S Acme Road

S. Acme Road at US 90: This intersection is an interchange between US 90 and S. Acme Road. The intersections are located at the frontage roads from US 90 at S. Acme Road. The westbound frontage road at S. Acme Road is controlled by a traffic signal, and the eastbound frontage road at S. Acme Road is controlled by a traffic signal. The US 90 frontage roads have two lanes, and S. Acme Road is a four lane roadway with two lanes in each direction. There is an exclusive left turn lane on the northbound approach of S. Acme Road at the westbound US 90 frontage road, and there is an exclusive left turn lane on the southbound approach of S. Acme Road at the eastbound US 90 frontage road. There is a channelized right turn lane and an exclusive left turn lane on the westbound US 90 frontage road. Aerial photographs of these intersections are shown in Figure A5 and Figure A6.

Figure A5. S. Acme Road at East Bound US 90 Frontage Road

Figure A6. S. Acme Road at West Bound US 90 Frontage Road

W. Military Drive at Luke Boulevard: This intersection is controlled by a traffic signal. W. Military Drive is six lanes with three lanes in each direction. There are exclusive dual left turn lanes and exclusive right turn lanes on both approaches of W. Military Drive. Luke Boulevard is four lanes with two lanes in each direction. There are exclusive left turn lanes on both approaches of Luke Boulevard. There are security gates on Luke Boulevard east and west of the intersection. An aerial photograph of this intersection is shown in Figure A7.

Figure A7. W. Military Drive at Luke Boulevard

W. Military Drive at Bergquist Drive: This intersection is a T-intersection controlled by a traffic signal. W. Military Drive is six lanes with three lanes in each direction. There are exclusive dual left turn lanes on the southbound approach of W. Military Drive, and a channelized right turn lane on the northbound approach. The southbound approach of W. Military Drive is striped to have two thru lanes at the approach and three thru lanes south of the intersection. Bergquist Drive is four lanes with two lanes in each direction. There is an exclusive left turn lane and a channelized right turn lane on the Bergquist Drive approach. There is a security gate on Bergquist Drive east of the intersection. An aerial photograph of this intersection is shown in Figure A8.

Figure A8. W. Military Drive at Bergquist Drive

W. Military Drive at US 90: This intersection is an interchange between US 90 and W. Military Drive. The intersections are located at the frontage roads from US 90 at W. Military Drive. The westbound frontage road at W. Military Drive is controlled by a traffic signal, and the eastbound frontage road at W. Military Drive is controlled by a traffic signal. The US 90 frontage roads have two lanes, and W. Military Drive is a four lane roadway with two lanes in each direction north of US 90 and a six lane roadway with three lanes in each direction south of US 90. There is an exclusive left turn lane on the northbound approach of W. Military Drive at the westbound US 90 frontage road, and there is an exclusive left turn lane on the southbound approach of W. Military Drive at the eastbound US 90 frontage road. There are also share thru/left turn lanes on the northbound approach of W. Military Drive at the westbound US 90 frontage road and on the southbound approach of W. Military Drive at the eastbound US 90 frontage road. The two lane approach of the eastbound US 90 frontage road is striped as one left turn lane and one thru lane at the intersection. The westbound US 90 frontage road has an exclusive left turn lane, a shared thru/left turn lane, a thru lane, and an exclusive right turn lane. Aerial photographs of these intersections are shown in Figure A9 and Figure A10.

Figure A9. W. Military Drive at East Bound US 90 Frontage Road

Figure A10. W. Military Drive at West Bound US 90 Frontage Road

Old US 90 at US 90: This is a T-Intersection that is controlled by a stop sign on the off ramp from westbound US 90. The westbound US 90 off ramp is two lanes with one thru lane continuing to westbound Old US 90 (which is one way westbound west of the intersection), and one channelized right turn lane. The eastbound US 90 off ramp to Old US 90 is one lane with an exclusive left turn lane at the intersection. This approach is free flowing as is the westbound Old US 90 approach which is two lanes. An aerial photograph of this intersection is shown in Figure A11.

Figure A11. Old US 90 at US 90

Callaghan Road at Old US 90: This intersection is controlled by a traffic signal. Callaghan Road is five lanes with two lanes in each direction and a continuous left turn lane which is striped as an exclusive left turn lane on both approaches at the intersection. Old US 90 is four lanes with two lanes in each direction. The eastbound and westbound approaches of Old US 90 have exclusive left turn lanes at the intersection. There are channelized right turn lanes on both approaches of Old US 90. An aerial photograph of this intersection is shown in Figure A12.

Figure A12. S. Callaghan Road at Old US 90

Appendix B – Traffic Count Data

US 90 at Callaghan Road – May 11, 2011

AM Counts

	CALLAGHAN RD From South				US 90 From West				CALLAGHAN RD From North				US 90 From East			
Start Time	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds
06:00 AM	0	7	0	0	0	0	0	0	0	16	8	0	8	3	10	0
06:15 AM	1	5	0	0	0	0	0	0	0	27	16	0	2	2	30	0
06:30 AM	0	5	0	0	0	0	0	0	0	34	14	0	7	3	13	0
06:45 AM	1	7	0	0	0	0	0	0	0	37	14	0	7	2	17	0
07:00 AM	2	17	0	0	0	0	0	0	0	30	15	0	9	7	6	0
07:15 AM	2	23	0	0	0	0	0	0	0	41	19	0	7	8	13	0
07:30 AM	1	26	0	0	0	0	0	0	0	39	14	0	12	5	29	0
07:45 AM	0	35	0	0	0	0	0	0	0	26	17	0	4	5	17	0
08:00 AM	2	33	0	0	0	0	0	0	0	34	12	0	3	8	14	0
08:15 AM	5	13	0	0	0	0	0	0	0	12	16	0	2	12	10	0
08:30 AM	1	10	0	0	0	0	0	0	0	15	5	0	2	13	8	0
08:45 AM	2	15	0	0	0	0	0	0	0	13	13	0	10	4	8	0

PM Counts

	CALLAGHAN RD From South				US 90 From West				CALLAGHAN RD From North				US 90 From East			
Start Time	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds
03:00 PM	1	7	0	0	0	0	0	0	0	16	8	0	10	13	18	0
03:15 PM	2	9	0	0	0	0	0	0	0	23	17	0	7	14	13	0
03:30 PM	0	12	0	0	0	0	0	0	0	15	15	0	5	24	19	0
03:45 PM	1	15	0	0	0	0	0	0	0	17	21	0	13	17	40	0
04:00 PM	1	7	0	0	0	0	0	0	0	8	19	0	4	19	31	0
04:15 PM	0	16	0	0	0	0	0	0	0	13	19	0	12	17	20	0
04:30 PM	3	17	0	0	0	0	0	0	0	16	26	0	11	17	25	0
04:45 PM	3	17	0	0	0	0	0	0	0	17	41	0	9	13	29	0
05:00 PM	2	9	0	0	0	0	0	0	0	9	36	0	4	15	31	0
05:15 PM	2	11	0	0	0	0	0	0	0	14	64	0	2	11	32	0
05:30 PM	1	15	0	0	0	0	0	0	0	12	42	0	6	12	36	0
05:45 PM	1	12	0	0	0	0	0	0	0	19	31	0	4	12	23	0

US 90 at Callaghan - AM Counts #2

	CALLAGHAN RD From North				US 90 From East				CALLAGHAN RD From South				US 90 From West			
Start Time	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds
6:00 AM	0	0	24	0	0	0	0	0	0	0	0	0	0	27	4	0
6:15 AM	0	0	48	0	0	0	0	0	0	0	0	0	0	17	6	0
6:30 AM	0	0	42	0	0	0	0	0	0	0	0	0	0	39	10	0
6:45 AM	0	0	43	0	0	0	0	0	0	0	0	0	0	53	11	0
7:00 AM	0	0	53	0	0	0	0	0	0	0	0	0	0	50	18	0
7:15 AM	0	0	55	0	0	0	0	0	0	0	0	0	1	57	27	0
7:30 AM	0	0	74	0	0	0	0	0	0	0	0	0	0	57	33	0
7:45 AM	0	0	38	0	0	0	0	0	0	0	0	0	0	45	39	0
8:00 AM	0	0	37	0	0	0	0	0	0	0	0	0	0	32	22	0
8:15 AM	0	0	16	0	0	0	0	0	0	0	0	0	0	41	21	0
8:30 AM	0	0	14	0	0	0	0	0	0	0	0	0	0	31	16	0
8:45 AM	0	0	26	0	0	0	0	0	0	0	0	0	0	37	9	0

US 90 at Callaghan - PM Counts #2

	CALLAGHAN RD From North				US 90 From East				CALLAGHAN RD From South				US 90 From West			
Start Time	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds
3:00 PM	0	0	36	0	0	0	0	0	0	0	0	0	0	21	8	0
3:15 PM	0	0	30	0	0	0	0	0	0	0	0	0	0	28	11	0
3:30 PM	0	1	22	0	0	0	0	0	0	0	0	0	0	19	16	0
3:45 PM	0	0	30	0	0	0	0	0	0	0	0	0	1	33	12	0
4:00 PM	0	0	12	0	0	0	0	0	0	0	0	0	0	26	11	0
4:15 PM	0	0	32	0	0	0	0	0	0	0	0	0	0	25	14	0
4:30 PM	0	0	34	0	0	0	0	0	0	0	0	0	0	24	24	0
4:45 PM	0	0	22	0	0	0	0	0	0	0	0	0	1	29	15	0
5:00 PM	0	0	19	0	0	0	0	0	0	0	0	0	0	26	12	0
5:15 PM	0	0	18	0	0	0	0	0	0	0	0	0	0	28	14	0
5:30 PM	0	0	19	0	0	0	0	0	0	0	0	0	0	29	16	0
5:45 PM	0	0	25	0	0	0	0	0	0	0	0	0	0	17	14	0

Castroville Road at Stotzer Freeway – May 12, 2011

AM Counts

Start Time	STOTZER HWY From North				CASTROVILLE RD From East				STOTZER HWY From South				CASTROVILLE RD From West			
	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds
06:00 AM	16	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 AM	28	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 AM	34	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 AM	30	0	2	0	0	24	1	0	0	0	0	0	0	3	0	0
07:00 AM	44	0	8	0	0	22	0	0	0	0	0	0	0	7	0	0
07:15 AM	35	0	1	0	0	21	0	0	0	0	0	0	0	9	0	0
07:30 AM	42	0	3	0	0	14	0	0	0	0	0	0	0	19	0	0
07:45 AM	34	0	6	0	0	27	0	0	0	0	0	0	0	25	0	0
08:00 AM	28	0	3	0	0	21	0	0	0	0	0	0	0	10	0	0
08:15 AM	27	0	6	0	0	24	0	0	0	0	0	0	0	5	0	0
08:30 AM	14	0	3	0	0	12	0	0	0	0	0	0	0	4	0	0
08:45 AM	10	0	4	0	0	6	0	0	0	0	0	0	0	6	0	0

PM Counts

Start Time	STOTZER HWY From North				CASTROVILLE RD From East				STOTZER HWY From South				CASTROVILLE RD From West			
	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds
03:00 PM	14	0	5	0	0	24	0	0	0	0	0	0	0	11	0	0
03:15 PM	17	0	1	0	0	19	0	0	0	0	0	0	0	15	0	0
03:30 PM	22	0	5	0	0	29	0	0	0	0	0	0	0	8	0	0
03:45 PM	16	0	6	0	0	30	0	0	0	0	0	0	0	14	0	0
04:00 PM	12	0	5	0	0	16	0	0	0	0	0	0	0	5	0	0
04:15 PM	18	0	2	0	0	23	0	0	0	0	0	0	0	4	0	0
04:30 PM	10	0	4	0	0	25	0	0	0	0	0	0	0	9	0	0
04:45 PM	11	0	0	0	0	25	0	0	0	0	0	0	0	8	0	0
05:00 PM	15	0	7	0	0	27	0	0	0	0	0	0	0	6	0	0
05:15 PM	11	0	4	0	0	27	4	0	0	0	0	0	0	8	0	0
05:30 PM	7	0	2	0	0	11	0	0	0	0	0	0	0	2	0	0
05:45 PM	7	0	2	0	0	10	0	0	0	0	0	0	0	6	0	0

Castroville Road at S. Acme Road – May 12, 2011

AM Counts

	CASTROVILLE RD From East				ACME RD From South				CASTROVILLE RD From West				ACME RD From South			
Start Time	R	Thru	L	Ped	R	Thru	L	Ped	R	Thru	L	Ped	R	Thru	L	Ped
06:00 AM	0	12	3	0	6	5	6	0	3	7	10	0	9	2	0	0
06:15 AM	0	22	3	0	5	7	7	0	5	17	2	0	29	1	1	0
06:30 AM	1	29	6	0	5	7	9	0	1	16	2	0	26	2	1	0
06:45 AM	2	32	5	0	8	14	17	0	2	23	11	0	35	4	0	0
07:00 AM	3	35	7	0	13	11	17	0	8	27	21	0	36	9	2	0
07:15 AM	4	28	11	0	15	8	9	0	6	42	13	0	29	12	3	0
07:30 AM	2	39	33	0	29	12	5	1	12	48	9	0	22	30	8	0
07:45 AM	1	52	38	0	53	26	14	0	20	34	11	0	18	47	3	0
08:00 AM	1	41	37	0	37	23	9	0	11	35	12	0	6	27	5	0
08:15 AM	3	8	10	0	12	13	9	0	18	23	10	0	19	17	0	0
08:30 AM	0	29	11	0	11	12	5	0	9	29	5	0	12	8	4	0
08:45 AM	1	20	16	0	17	7	8	0	11	19	6	0	6	9	0	0

PM Counts

	CASTROVILLE RD From East				ACME RD From South				CASTROVILLE RD From West				ACME RD From South			
Start Time	R	Thru	L	Ped	R	Thru	L	Ped	R	Thru	L	Ped	R	Thru	L	Ped
3:00 PM	4	26	13	0	12	13	10	0	7	41	2	0	5	22	6	0
3:15 PM	2	25	14	0	34	27	19	0	15	48	4	0	10	20	9	0
3:30 PM	4	36	15	0	37	18	18	0	8	45	12	0	6	12	7	0
3:45 PM	1	18	23	0	18	16	16	0	7	48	5	0	5	15	7	0
4:00 PM	2	28	5	0	27	15	19	0	23	42	5	0	9	10	6	0
4:15 PM	1	23	8	0	21	19	19	0	10	43	12	0	1	11	3	0
4:30 PM	0	20	14	0	20	21	23	0	9	59	7	0	5	10	3	0
4:45 PM	2	19	10	0	19	19	20	1	10	62	6	0	0	12	5	0
5:00 PM	1	23	7	0	21	20	30	0	7	48	7	0	8	14	7	0
5:15 PM	2	20	12	0	18	12	29	0	9	41	5	0	1	4	5	0
5:30 PM	0	21	17	0	29	10	22	0	14	30	2	0	1	8	1	0
5:45 PM	2	23	15	0	17	13	11	0	7	31	5	0	4	10	3	0

S. Acme Road at US 90 – May 10, 2011

AM Counts

	ACME RD From South				US 90 From West				ACME RD From North				US 90 From East			
Start Time	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds
06:00 AM	2	6	0	0	0	0	1	0	0	27	13	0	77	9	11	0
06:15 AM	4	9	2	0	0	0	0	0	0	44	15	0	140	25	7	0
06:30 AM	7	13	0	0	0	0	0	0	0	53	21	0	139	24	16	0
06:45 AM	11	31	0	0	0	0	0	0	0	60	26	0	132	44	25	0
07:00 AM	8	23	1	0	0	0	0	0	0	41	24	0	118	38	27	0
07:15 AM	3	32	0	0	0	0	0	0	0	42	20	0	110	45	28	0
07:30 AM	3	29	0	0	0	0	0	0	0	46	22	0	86	38	28	0
07:45 AM	5	39	1	0	0	0	0	0	0	37	31	0	67	33	31	0
08:00 AM	5	28	0	0	0	0	0	0	0	31	22	0	70	31	37	0
08:15 AM	1	19	0	0	0	0	0	0	0	21	21	0	59	35	15	0
08:30 AM	5	26	0	0	0	0	0	0	0	29	12	0	65	27	18	0
08:45 AM	5	19	0	0	0	0	0	0	0	21	15	0	45	28	19	0

PM Counts

	ACME RD From South				US 90 From West				ACME RD From North				US 90 From East			
Start Time	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds
03:00 PM	14	23	0	0	0	0	0	0	0	16	19	0	32	63	26	0
03:15 PM	13	30	0	0	0	0	0	0	0	16	20	0	27	57	24	0
03:30 PM	17	23	0	0	0	0	0	0	0	31	28	0	31	74	29	0
03:45 PM	29	30	3	0	0	0	0	0	0	24	31	0	38	88	36	0
04:00 PM	0	20	0	0	0	0	0	0	0	18	37	0	43	85	35	1
04:15 PM	40	58	0	0	0	0	0	0	0	27	36	0	29	79	22	0
04:30 PM	52	44	0	0	0	0	0	0	0	20	46	0	15	64	29	0
04:45 PM	53	51	0	0	0	0	0	0	0	14	43	0	35	83	54	0
05:00 PM	49	38	0	0	0	0	0	0	0	18	60	0	39	84	24	0
05:15 PM	33	46	0	0	0	0	0	0	0	20	44	0	20	82	32	0
05:30 PM	23	37	0	0	0	0	0	0	0	19	39	0	19	72	18	0
05:45 PM	9	27	0	0	0	0	0	0	0	13	38	0	15	71	24	0

S. Acme Road at US 90 – AM Counts #2

	ACME RD From North				US 90 From East				ACME RD From South				US 90 From West			
Start Time	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds
6:00 AM	4	135	15	0	0	0	0	0	15	5	0	0	27	6	11	0
6:15 AM	1	184	13	0	0	0	0	0	7	4	0	0	38	2	8	0
6:30 AM	0	194	27	0	0	0	0	0	14	15	1	0	64	11	14	0
6:45 AM	0	165	30	0	0	0	0	0	17	15	0	0	51	12	30	0
7:00 AM	1	136	23	0	0	0	0	0	18	8	0	0	45	16	20	0
7:15 AM	0	124	18	0	0	0	0	0	15	10	0	0	28	15	37	0
7:30 AM	0	99	35	0	0	0	0	0	20	5	0	0	25	10	34	0
7:45 AM	1	92	22	0	0	0	0	0	16	3	0	0	39	19	41	0
8:00 AM	1	70	26	0	0	0	0	0	24	9	2	0	17	9	19	0
8:15 AM	1	86	20	0	0	0	0	0	28	7	0	0	12	6	15	0
8:30 AM	0	54	22	0	0	0	0	0	28	7	0	0	19	3	19	0
8:45 AM	0	53	14	0	0	0	0	0	27	19	0	0	8	5	25	0

S. Acme Road at US 90 – PM Counts #2

	ACME RD From North				US 90 From East				ACME RD From South				US 90 From West			
Start Time	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds
3:00 PM	1	27	17	0	0	0	0	0	95	27	0	0	4	7	15	0
3:15 PM	0	33	20	0	0	0	0	0	55	40	2	0	7	6	11	0
3:30 PM	1	29	34	0	0	0	0	0	132	57	0	0	11	9	16	0
3:45 PM	0	44	25	0	0	0	0	0	79	28	0	0	4	7	17	0
4:00 PM	0	33	32	0	0	0	0	0	132	58	0	0	7	8	21	0
4:15 PM	0	36	26	0	0	0	0	0	194	103	1	0	2	2	31	0
4:30 PM	0	21	11	0	2	0	0	0	197	113	0	0	3	6	13	0
4:45 PM	0	33	25	0	0	0	2	0	184	98	2	0	3	22	33	0
5:00 PM	0	18	30	0	0	0	0	0	129	74	0	0	3	8	31	0
5:15 PM	0	11	29	0	0	0	0	0	89	53	0	0	4	9	20	0
5:30 PM	0	12	16	0	0	0	0	0	49	34	0	0	6	4	14	0
5:45 PM	0	21	12	0	0	0	0	0	47	32	0	0	2	2	17	0

W. Military Drive at Luke Boulevard – May 17, 2011

AM Counts

	MILITARY DR From North				LUKE BLVD From East				MILITARY DR From South				LUKE BLVD From West			
Start Time	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds
6:00 AM	0	0	133	0	21	2	1	0	20	62	3	0	0	6	3	0
6:15 AM	0	0	126	0	9	2	0	1	8	73	3	0	0	7	7	0
6:30 AM	0	0	179	0	19	2	1	0	15	71	32	0	0	6	6	0
6:45 AM	0	0	173	0	28	1	1	0	22	107	24	0	0	16	0	0
7:00 AM	0	0	127	0	9	6	2	0	24	65	11	0	0	9	1	0
7:15 AM	0	0	128	0	23	10	7	0	32	124	13	0	0	40	8	0
7:30 AM	0	0	119	0	30	6	7	0	24	141	13	0	0	19	3	0
7:45 AM	0	0	89	0	19	2	2	0	14	154	5	0	0	12	1	0
8:00 AM	0	0	76	0	23	5	2	0	5	100	3	0	0	3	7	0
8:15 AM	0	0	69	0	25	5	5	0	7	109	5	0	0	1	10	0
8:30 AM	3	0	58	0	25	5	6	0	8	105	2	0	0	1	13	0
8:45 AM	0	0	57	0	22	2	6	0	10	105	9	0	0	6	7	0

PM Counts

	MILITARY DR From North				LUKE BLVD From East				MILITARY DR From South				LUKE BLVD From West			
Start Time	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds
3:00 PM	0	0	43	0	73	6	12	0	2	238	6	0	0	16	14	0
3:15 PM	0	1	22	0	62	18	6	0	4	197	3	0	0	3	17	0
3:30 PM	0	0	20	0	96	10	12	2	9	271	3	0	0	3	38	0
3:45 PM	0	0	28	0	106	5	13	5	5	366	3	0	0	7	30	0
4:00 PM	0	0	40	0	125	9	14	0	6	343	2	0	1	4	76	0
4:15 PM	0	0	42	0	151	4	10	0	8	335	6	0	0	6	45	0
4:30 PM	0	0	29	0	154	6	18	1	5	263	7	0	0	10	80	0
4:45 PM	0	0	52	0	181	3	14	0	8	332	6	0	0	8	62	0
5:00 PM	0	0	47	0	179	2	8	0	2	244	0	0	0	3	39	0
5:15 PM	0	0	43	0	153	4	3	0	21	207	0	0	0	10	33	0
5:30 PM	0	0	41	0	109	7	3	0	2	236	2	0	0	4	20	0
5:45 PM	0	0	64	0	98	2	6	0	5	203	0	0	0	2	12	0

W. Military Drive at Bergquist Drive – May 18, 2011

AM Counts

	MILITARY DR From North				BERGQUIST DR From East				MILITARY DR From South				BERGQUIST DR From West			
Start Time	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds
06:00 AM	63	262	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 AM	183	362	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 AM	249	558	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 AM	223	673	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 AM	257	635	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 AM	264	555	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 AM	203	458	7	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 AM	165	358	1	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 AM	107	352	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 AM	127	217	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 AM	97	213	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 AM	94	253	1	0	0	0	0	0	0	0	0	0	0	0	0	0

PM Counts

	MILITARY DR From North				BERGQUIST DR From East				MILITARY DR From South				BERGQUIST DR From West			
Start Time	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds	L	Thru	R	Peds
3:00 PM	37	209	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:15 PM	38	215	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:30 PM	30	157	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	30	170	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	21	177	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	14	218	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	27	216	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	21	202	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	11	241	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	12	239	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	10	278	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	14	222	0	0	0	0	0	0	0	0	0	0	0	0	0	0

W. Military Drive at Bergquist Drive AM Counts #2

	BERGQUIST DR From East				MILITARY DR From South				BERGQUIST DR From West				MILITARY DR From North			
Start Time	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds
07:00 AM	5	0	0	0	4	101	0	0	0	0	2	0	0	0	2	0
07:15 AM	13	0	0	0	3	104	0	0	0	0	0	0	0	0	0	0
07:30 AM	14	0	5	0	4	115	0	0	0	0	0	0	0	0	0	0
07:45 AM	17	0	3	0	3	119	0	0	0	0	0	0	0	0	0	0
08:00 AM	9	0	2	0	2	148	0	0	0	0	0	0	0	0	0	0
08:15 AM	20	1	3	0	4	198	0	0	0	0	0	0	0	0	0	0
08:30 AM	12	0	0	0	1	198	0	0	0	0	0	0	0	0	0	0
08:45 AM	31	0	3	0	1	165	0	0	1	0	0	0	1	0	0	0
09:00 AM	19	0	5	0	1	150	0	0	0	0	0	0	0	0	0	0
09:15 AM	23	0	0	0	3	151	0	0	0	0	0	0	0	0	0	0
09:30 AM	32	0	0	0	7	165	0	0	0	0	0	0	0	0	0	0
09:45 AM	39	0	7	0	1	158	0	0	0	0	0	0	0	0	0	0

W. Military Drive at Bergquist Drive PM Counts #2

	BERGQUIST DR From East				MILITARY DR From South				BERGQUIST DR From West				MILITARY DR From North			
Start Time	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds
3:00 PM	152	0	5	0	0	307	0	0	0	0	0	0	0	0	0	0
3:15 PM	105	0	2	3	2	364	1	0	0	0	0	0	0	0	0	0
3:30 PM	126	0	6	0	5	435	0	0	0	0	0	0	0	0	0	0
3:45 PM	135	1	3	0	1	512	0	0	0	0	0	0	0	0	0	0
4:00 PM	208	1	7	5	0	587	0	0	0	0	0	0	0	0	0	0
4:15 PM	273	0	7	0	2	636	0	0	0	31	0	0	0	31	0	0
4:30 PM	259	1	11	0	1	555	1	0	0	0	0	0	0	0	0	0
4:45 PM	305	0	5	0	2	576	0	0	0	0	0	0	0	0	0	0
5:00 PM	195	0	9	0	1	557	1	0	0	0	0	0	0	0	0	0
5:15 PM	102	0	2	0	0	456	0	0	0	0	0	0	0	0	0	0
5:30 PM	58	0	3	0	0	414	0	0	0	0	0	0	0	0	0	0
5:45 PM	39	0	0	0	0	371	0	0	0	0	0	0	0	0	0	0

W. Military Drive at US 90 – May 19, 2011

AM Counts

	MILITARY DR From North				US 90 From East				MILITARY DR From South				US 90 From West			
Start Time	L	Thru	R	Ped	L	Thru	R	Ped	L	Thru	R	Ped	L	Thru	R	Ped
06:00 AM	67	167	0	0	0	0	0	0	0	0	0	0	32	7	214	0
06:15 AM	51	283	0	0	0	0	0	0	0	0	0	0	44	5	314	0
06:30 AM	62	476	0	0	0	0	0	0	0	0	0	0	35	2	386	0
06:45 AM	77	483	0	0	0	0	0	0	0	0	0	0	30	12	341	0
07:00 AM	53	465	0	0	0	0	0	0	0	0	0	0	22	4	373	0
07:15 AM	75	467	0	0	0	0	0	0	0	0	0	0	34	7	350	0
07:30 AM	144	374	0	0	0	0	0	0	0	0	0	0	50	12	305	0
07:45 AM	152	291	0	0	0	0	0	0	0	0	0	0	66	12	250	0
08:00 AM	107	234	0	0	0	0	0	0	0	0	0	0	89	8	220	0
08:15 AM	72	207	10	0	0	0	0	0	0	0	0	0	94	18	156	0
08:30 AM	90	186	0	0	0	0	0	0	0	0	0	0	91	15	152	0
08:45 AM	73	176	0	0	0	0	0	0	0	0	0	0	78	15	137	0

PM Counts

	MILITARY DR From North				US 90 From East				MILITARY DR From South				US 90 From West			
Start Time	L	Thru	R	Ped	L	Thru	R	Ped	L	Thru	R	Ped	L	Thru	R	Ped
3:00 PM	105	188	0	0	0	0	0	0	0	0	0	0	135	12	92	0
3:15 PM	104	155	0	0	0	0	0	0	0	0	0	0	110	15	99	0
3:30 PM	84	165	0	0	0	0	0	0	0	0	0	0	100	18	88	0
3:45 PM	83	153	0	0	0	0	0	0	0	0	0	0	113	17	87	0
4:00 PM	80	129	0	0	0	0	0	0	0	0	0	0	116	22	79	0
4:15 PM	96	164	1	0	0	0	0	0	0	0	0	0	111	13	58	0
4:30 PM	87	141	0	0	0	0	0	0	0	0	0	0	103	10	66	0
4:45 PM	99	198	0	0	0	0	0	0	0	0	0	0	121	17	75	0
5:00 PM	92	159	0	0	0	0	0	0	0	0	0	0	118	15	73	0
5:15 PM	85	163	0	0	0	0	0	0	0	0	0	0	131	22	79	0
5:30 PM	92	201	0	0	0	0	0	0	0	0	0	0	124	14	75	0
5:45 PM	107	162	0	0	0	0	0	0	0	0	0	0	122	12	84	0

W. Military Drive at US 90 - AM Counts

	US 90 From West				MILITARY DR From North				US 90 From East				MILITARY DR From South			
Start Time	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds
06:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	64	117	1	3
06:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	57	89	0	0
06:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	69	124	0	0
06:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	68	104	0	0
07:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	85	153	0	0
07:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	82	151	0	0
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	111	200	0	0
07:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	100	217	0	0
08:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	81	143	0	0
08:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	68	186	0	0
08:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	91	166	0	0
08:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	56	123	0	0

W. Military Drive at US 90 - PM Counts

	US 90 From West				MILITARY DR From North				US 90 From East				MILITARY DR From South			
Start Time	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	148	453	0	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	208	414	0	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	256	514	0	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	260	534	0	0
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	345	552	0	4
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	281	577	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	197	530	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	310	566	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	197	534	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	160	482	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	152	384	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	150	431	0	0

W. Military Drive at US 90 - AM Counts

	US 90 From West				MILITARY DR From North				US 90 From East				MILITARY DR From South			
Start Time	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds
06:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 AM	0	0	0	0	12	230	0	0	29	23	202	0	0	49	33	0
07:30 AM	0	0	0	0	13	226	0	0	39	26	216	0	0	63	63	0
07:45 AM	0	0	0	0	13	303	0	0	40	30	167	0	0	70	81	0
08:00 AM	0	0	0	0	9	301	0	0	47	32	123	0	0	68	96	0
08:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

W. Military Drive at US 90 - PM Counts

	US 90 From West				MILITARY DR From North				US 90 From East				MILITARY DR From South			
Start Time	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds
3:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	0	0	0	0	36	121	0	0	53	50	81	0	0	184	263	0
4:15 PM	0	0	0	0	51	123	0	0	67	56	88	0	0	193	311	0
4:30 PM	0	0	0	0	43	121	0	0	60	53	96	0	0	219	310	0
4:45 PM	0	0	0	0	24	113	0	0	64	50	84	0	0	203	335	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

US 90 at Old US 90 West – May 24, 2011

AM Counts

	US 90 From North				OLD US 90 From East				US 90 From South				OLD US 90 From West			
Start Time	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds
06:00 AM	15	2	0	0	1	0	0	0	1	18	5	0	0	1	0	0
06:15 AM	35	0	0	0	4	1	0	0	0	29	7	0	0	0	0	0
06:30 AM	33	0	0	0	4	0	0	0	0	27	5	0	0	0	0	0
06:45 AM	47	0	0	0	3	3	0	0	0	27	6	0	0	0	0	0
07:00 AM	7	0	0	0	4	0	0	0	0	5	2	0	0	0	0	0
07:15 AM	6	5	0	25	0	0	0	0	0	20	10	0	0	0	0	0
07:30 AM	5	5	0	25	0	0	0	0	0	22	15	0	0	0	0	0
07:45 AM	5	0	0	25	0	0	0	0	0	18	5	0	0	0	0	0
08:00 AM	5	5	0	18	0	0	0	0	0	22	11	0	0	0	0	0
08:15 AM	8	0	0	22	0	0	0	0	0	24	10	0	0	0	0	0
08:30 AM	2	5	0	19	0	0	0	0	0	23	6	0	0	0	0	0
08:45 AM	6	1	0	17	0	0	0	0	0	25	8	0	0	0	0	0

PM Counts

	US 90 From North				OLD US 90 From East				US 90 From South				OLD US 90 From West			
Start Time	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds	R	Thru	L	Peds
3:00 PM	9	7	0	0	61	0	0	0	0	40	3	0	0	0	0	0
3:15 PM	5	14	0	0	43	0	0	0	0	36	3	0	0	0	0	0
3:30 PM	7	8	0	0	32	0	0	0	0	35	2	0	0	0	0	0
3:45 PM	6	9	0	0	33	0	0	0	0	45	2	0	0	0	0	0
4:00 PM	13	8	0	0	51	0	0	0	0	53	2	0	0	0	0	0
4:15 PM	16	8	0	0	54	0	0	0	0	46	2	0	0	0	0	0
4:30 PM	22	20	0	0	51	0	0	0	0	61	0	0	0	0	0	0
4:45 PM	17	13	0	0	48	0	0	0	0	61	1	0	0	0	0	0
5:00 PM	10	7	0	0	84	0	0	0	0	74	1	0	0	0	0	0
5:15 PM	9	10	0	0	51	0	0	0	0	48	4	0	0	0	0	0
5:30 PM	5	3	0	0	53	0	0	0	0	35	2	0	0	0	0	0
5:45 PM	7	8	0	0	61	0	0	0	0	35	2	0	0	0	0	0

Callaghan Road at Old US 90 – May 25, 2011

AM Counts

	OLD US 90 From North				CALLAGHAN RD From East				OLD US 90 From South				CALLAGHAN RD From West			
Start Time	L	Thru	R	Ped	L	Thru	R	Ped	L	Thru	R	Ped	L	Thru	R	Ped
06:00 AM	4	24	12	1	0	19	3	0	14	5	2	0	3	24	5	0
06:15 AM	2	19	28	0	0	25	2	0	25	7	4	0	4	38	3	0
06:30 AM	1	30	30	0	0	19	4	1	18	3	2	0	8	47	4	0
06:45 AM	6	59	29	1	3	28	6	0	3	14	5	0	18	50	16	0
07:00 AM	5	30	18	0	2	18	4	0	6	17	1	0	21	63	9	0
07:15 AM	9	32	19	0	1	26	3	0	12	17	3	0	16	38	10	0
07:30 AM	7	33	21	0	3	23	3	0	21	27	9	0	34	76	10	0
07:45 AM	14	20	29	0	4	46	2	0	6	25	7	0	54	78	10	0
08:00 AM	7	33	16	0	8	40	4	0	16	21	3	0	28	52	9	0
08:15 AM	3	17	31	0	4	34	6	0	4	18	2	0	14	50	5	0
08:30 AM	8	19	23	0	3	33	9	0	9	16	4	0	22	45	4	0
08:45 AM	3	22	14	0	3	39	7	0	7	12	2	0	23	41	5	0

PM Counts

	OLD US 90 From North				CALLAGHAN RD From East				OLD US 90 From South				CALLAGHAN RD From West			
Start Time	L	Thru	R	Ped	L	Thru	R	Ped	L	Thru	R	Ped	L	Thru	R	Ped
03:00 PM	6	16	12	0	8	40	12	0	7	19	10	0	25	84	29	0
03:15 PM	7	25	13	0	6	39	14	0	6	19	7	0	24	51	22	0
03:30 PM	9	20	18	0	6	41	22	1	9	22	5	0	26	39	6	0
03:45 PM	10	26	16	0	4	49	3	0	10	26	9	0	25	65	15	0
04:00 PM	3	21	24	0	5	56	1	0	9	28	4	0	40	58	13	0
04:15 PM	6	22	17	0	6	76	9	0	10	38	2	0	38	70	6	1
04:30 PM	2	26	17	0	11	62	5	0	17	32	2	0	31	81	11	0
04:45 PM	8	33	11	0	3	46	5	0	13	27	7	0	39	60	19	0
05:00 PM	7	57	20	0	12	54	8	0	9	37	9	0	37	57	25	0
05:15 PM	5	34	15	0	11	41	14	0	4	23	2	0	34	39	18	0
05:30 PM	5	42	36	3	4	51	8	0	16	23	4	0	30	50	9	1
05:45 PM	6	54	33	0	4	66	13	0	9	29	4	0	32	67	8	0

Appendix C – HCM Worksheets

AM Peak Hour Capacity Analysis

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱						↑↱		↰	↰↑	
Volume (vph)	117	53	109	0	0	0	0	27	75	101	388	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		0	100		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		55			30			45			45	
Link Distance (ft)		437			308			224			280	
Travel Time (s)		5.4			7.0			3.4			4.2	
Peak Hour Factor	0.76	0.82	0.84	0.92	0.92	0.92	0.92	0.85	0.77	0.80	0.82	0.92
Shared Lane Traffic (%)										10%		
Act Effct Green (s)		11.0						9.2		12.7	12.7	
Actuated g/C Ratio		0.33						0.28		0.39	0.39	
v/c Ratio		0.30						0.14		0.24	0.39	
Control Delay		6.5						5.4		9.5	9.7	
Queue Delay		0.0						0.0		0.0	0.0	
Total Delay		6.5						5.4		9.5	9.7	
LOS		A						A		A	A	
Approach Delay		6.5						5.4			9.6	
Approach LOS		A						A			A	

Intersection Summary

Area Type: Other
Cycle Length: 50
Actuated Cycle Length: 32.9
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.46
Intersection Signal Delay: 8.1 Intersection LOS: A
Intersection Capacity Utilization 27.1% ICU Level of Service A
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	333	147	124	16	128	0	0	156	95
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	100		0	0		0
Storage Lanes	0		0	1		1	1		0	0		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			55			45			45	
Link Distance (ft)		145			222			280			110	
Travel Time (s)		3.3			2.8			4.2			1.7	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)				29%			10%					
Act Effct Green (s)				11.0	11.0	11.0	11.3	9.8			12.2	
Actuated g/C Ratio				0.33	0.33	0.33	0.34	0.30			0.37	
v/c Ratio				0.46	0.46	0.22	0.04	0.15			0.21	
Control Delay				12.8	12.6	3.6	9.1	12.4			6.0	
Queue Delay				0.0	0.0	0.0	0.0	0.0			0.0	
Total Delay				12.8	12.6	3.6	9.1	12.4			6.0	
LOS				B	B	A	A	B			A	
Approach Delay					10.8			12.1			6.0	
Approach LOS					B			B			A	

Intersection Summary

Area Type: Other
Cycle Length: 50
Actuated Cycle Length: 32.9
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.46
Intersection Signal Delay: 9.8 — Intersection LOS: A
Intersection Capacity Utilization 27.1% — ICU Level of Service A
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑	↱		↰↑↱		↰	↑↱		↰	↑↱	
Volume (vph)	45	159	49	102	160	8	37	81	134	19	100	75
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		115	0		0	80		0	0		0
Storage Lanes	0		1	0		0	1		0	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Link Speed (mph)		45			45			45			45	
Link Distance (ft)		361			788			110			2695	
Travel Time (s)		5.5			11.9			1.7			40.8	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)												
Sign Control		Stop			Stop			Stop			Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 36.6% ICU Level of Service A
Analysis Period (min) 15

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑↑	↑↑		↰	↱
Volume (veh/h)	0	114	272	0	139	13
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.63	0.78	0.92	0.83	0.54
Hourly flow rate (vph)	0	181	349	0	167	24
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	349				439	174
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	349				439	174
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				69	97
cM capacity (veh/h)	1207				546	839

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	90	90	174	174	167	24
Volume Left	0	0	0	0	167	0
Volume Right	0	0	0	0	0	24
cSH	1700	1700	1700	1700	546	839
Volume to Capacity	0.05	0.05	0.10	0.10	0.31	0.03
Queue Length 95th (ft)	0	0	0	0	32	2
Control Delay (s)	0.0	0.0	0.0	0.0	14.5	9.4
Lane LOS					B	A
Approach Delay (s)	0.0		0.0		13.8	
Approach LOS					B	

Intersection Summary			
Average Delay	3.7		
Intersection Capacity Utilization	21.9%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↰↑			↰↰	
Volume (vph)	121	191	0	0	204	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Link Speed (mph)		30	30		30	
Link Distance (ft)		231	221		220	
Travel Time (s)		5.3	5.0		5.0	
Peak Hour Factor	0.78	0.84	0.92	0.92	0.68	0.92
Shared Lane Traffic (%)						
Sign Control		Free	Stop		Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 30.7% ICU Level of Service A
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↶↑↱		↰	↑↑			↑↱	
Volume (vph)	0	0	0	26	26	73	5	116	0	0	178	62
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Link Speed (mph)		30			45			40			40	
Link Distance (ft)		260			110			220			1751	
Travel Time (s)		5.9			1.7			3.8			29.8	
Peak Hour Factor	0.92	0.92	0.92	0.54	0.81	0.63	0.63	0.84	0.92	0.92	0.85	0.82
Shared Lane Traffic (%)												
Sign Control		Stop			Stop			Stop			Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 23.2% ICU Level of Service A
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↱		↰	↑↱		↰	↑↱		↰	↑↱	
Volume (vph)	125	255	39	10	113	12	45	86	20	35	115	87
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	95		0	70		0	100		0	250		0
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		45			45			45			45	
Link Distance (ft)		2427			2704			1751			636	
Travel Time (s)		36.8			41.0			26.5			9.6	
Peak Hour Factor	0.58	0.82	0.98	0.31	0.61	0.75	0.54	0.80	0.56	0.63	0.87	0.75
Shared Lane Traffic (%)												
Act Effct Green (s)	12.0	12.0		12.0	12.0		11.3	12.0		8.2	8.2	
Actuated g/C Ratio	0.39	0.39		0.39	0.39		0.37	0.39		0.27	0.27	
v/c Ratio	0.47	0.25		0.08	0.15		0.19	0.11		0.16	0.26	
Control Delay	13.2	7.7		8.8	7.5		8.1	5.8		13.8	7.9	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	13.2	7.7		8.8	7.5		8.1	5.8		13.8	7.9	
LOS	B	A		A	A		A	A		B	A	
Approach Delay		9.8			7.7			6.6			9.0	
Approach LOS		A			A			A			A	

Intersection Summary

Area Type: Other
Cycle Length: 50
Actuated Cycle Length: 30.7
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.47
Intersection Signal Delay: 8.7 — Intersection LOS: A
Intersection Capacity Utilization 34.3% — ICU Level of Service A
Analysis Period (min) 15

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑	↱	↰	↑				↱↱
Volume (veh/h)	0	0	0	0	15	21	41	81	0	0	0	93
Sign Control		Yield			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.75	0.88	0.68	0.92	0.92	0.92	0.92	0.93
Hourly flow rate (vph)	0	0	0	0	20	24	60	88	0	0	0	100
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	219	209	0	209	309	88	100			88		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	219	209	0	209	309	88	100			88		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	97	98	96			100		
cM capacity (veh/h)	679	660	1085	726	581	970	1493			1508		

Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	20	24	60	88	50	50
Volume Left	0	0	60	0	0	0
Volume Right	0	24	0	0	50	50
cSH	581	970	1493	1700	1700	1700
Volume to Capacity	0.03	0.02	0.04	0.05	0.03	0.03
Queue Length 95th (ft)	3	2	3	0	0	0
Control Delay (s)	11.4	8.8	7.5	0.0	0.0	0.0
Lane LOS	B	A	A			
Approach Delay (s)	10.0		3.1		0.0	
Approach LOS	A					

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	20.0%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↰	↰↑	↱	↰	↰↑			↑↱	
Volume (vph)	0	0	0	708	111	155	319	400	0	0	1162	47
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	370		190	0		0	0		0
Storage Lanes	0		0	1		1	1		0	0		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			55			45			45	
Link Distance (ft)		346			373			245			328	
Travel Time (s)		7.9			4.6			3.7			5.0	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)				50%			44%					
Act Effct Green (s)				50.0	50.0	50.0	32.0	32.0			34.0	
Actuated g/C Ratio				0.50	0.50	0.50	0.32	0.32			0.34	
v/c Ratio				0.48	0.31	0.19	1.47	1.11dl			1.10	
Control Delay				18.9	15.4	2.7	271.8	37.1			88.8	
Queue Delay				36.2	0.5	0.0	0.0	0.0			21.7	
Total Delay				55.1	15.9	2.7	271.8	37.1			110.5	
LOS				E	B	A	F	D			F	
Approach Delay					28.1			95.3			110.5	
Approach LOS					C			F			F	

Intersection Summary

Area Type: Other
Cycle Length: 100
Actuated Cycle Length: 100
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.73
Intersection Signal Delay: 79.1 Intersection LOS: E
Intersection Capacity Utilization 140.6% ICU Level of Service H
Analysis Period (min) 15
dl Defacto Left Lane. Recode with 1 though lane as a left lane.

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑	↱					↑↑↱		↰	↰↑↑	
Volume (vph)	239	39	1125	0	0	0	0	480	227	478	1392	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		485	0		0	0		0	0		0
Storage Lanes	1		1	0		0	0		0	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		55			30			45			45	
Link Distance (ft)		384			311			455			245	
Travel Time (s)		4.8			7.1			6.9			3.7	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)	42%									10%		
Act Effct Green (s)	50.0	50.0	50.0					28.0		42.0	42.0	
Actuated g/C Ratio	0.50	0.50	0.50					0.28		0.42	0.42	
v/c Ratio	0.18	0.18	1.54					0.53		1.73	1.25	
Control Delay	14.5	14.4	271.8					27.1		360.8	138.9	
Queue Delay	0.0	0.0	0.0					0.0		0.0	36.9	
Total Delay	14.5	14.4	271.8					27.1		360.8	175.8	
LOS	B	B	F					C		F	F	
Approach Delay		220.9						27.1			218.4	
Approach LOS		F						C			F	

Intersection Summary

Area Type: Other
Cycle Length: 100
Actuated Cycle Length: 100
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.73
Intersection Signal Delay: 185.3 Intersection LOS: F
Intersection Capacity Utilization 140.6% ICU Level of Service H
Analysis Period (min) 15

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	11	82	625	7	739	1778
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0		0	275	
Storage Lanes	1	1		0	1	
Taper Length (ft)	25	25		25	25	
Right Turn on Red		Yes		Yes		
Link Speed (mph)	30		55			55
Link Distance (ft)	648		1229			564
Travel Time (s)	14.7		15.2			7.0
Peak Hour Factor	0.55	0.66	0.90	0.44	0.70	0.78
Shared Lane Traffic (%)						
Act Effct Green (s)	6.4	49.1	17.2		21.7	46.8
Actuated g/C Ratio	0.13	1.00	0.35		0.44	0.95
v/c Ratio	0.09	0.08	0.40		0.70	0.68
Control Delay	24.7	0.1	14.0		15.1	3.1
Queue Delay	0.0	0.0	0.0		0.0	0.0
Total Delay	24.7	0.1	14.0		15.1	3.1
LOS	C	A	B		B	A
Approach Delay	3.5		14.0			6.9
Approach LOS	A		B			A

Intersection Summary

Area Type: Other
Cycle Length: 75
Actuated Cycle Length: 49.1
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.70
Intersection Signal Delay: 8.0 — Intersection LOS: A
Intersection Capacity Utilization 59.1% — ICU Level of Service B
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑↱		↰	↰↑↱		↰↰	↑↑↑	↱	↰↰	↑↑↑	↱
Volume (vph)	18	75	9	18	23	95	34	519	75	427	1043	319
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	100		0	95		0	460		890	480		830
Storage Lanes	1		0	1		0	2		1	2		1
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			30			55			55	
Link Distance (ft)		296			543			2924			1229	
Travel Time (s)		6.7			12.3			36.2			15.2	
Peak Hour Factor	0.64	0.46	0.75	0.64	0.58	0.79	0.65	0.84	0.59	0.80	0.84	0.47
Shared Lane Traffic (%)	10%			10%								
Act Effct Green (s)	8.3	8.3		6.7	6.7		4.1	13.6	13.6	11.3	24.7	24.7
Actuated g/C Ratio	0.15	0.15		0.12	0.12		0.08	0.25	0.25	0.21	0.46	0.46
v/c Ratio	0.10	0.34		0.12	0.34		0.20	0.48	0.26	0.74	0.53	0.62
Control Delay	22.8	23.0		24.9	11.3		28.4	19.2	5.8	30.4	13.6	4.4
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	22.8	23.0		24.9	11.3		28.4	19.2	5.8	30.4	13.6	4.4
LOS	C	C		C	B		C	B	A	C	B	A
Approach Delay		23.0			13.1			17.7			14.7	
Approach LOS		C			B			B			B	

Intersection Summary

Area Type: Other
Cycle Length: 75
Actuated Cycle Length: 53.7
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.74
Intersection Signal Delay: 15.7 Intersection LOS: B
Intersection Capacity Utilization 40.8% ICU Level of Service A
Analysis Period (min) 15

PM Peak Hour Capacity Analysis

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱						↑↱		↰	↰↑	
Volume (vph)	98	38	15	0	0	0	0	300	707	94	107	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		0	100		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		55			30			45			45	
Link Distance (ft)		437			308			224			280	
Travel Time (s)		5.4			7.0			3.4			4.2	
Peak Hour Factor	0.74	0.43	0.53	0.92	0.92	0.92	0.92	0.90	0.90	0.73	0.86	0.92
Shared Lane Traffic (%)										42%		
Act Effct Green (s)		12.9						16.2		16.5	15.5	
Actuated g/C Ratio		0.31						0.39		0.39	0.37	
v/c Ratio		0.23						0.67		0.25	0.20	
Control Delay		11.2						6.7		11.0	10.4	
Queue Delay		0.0						0.0		0.0	0.0	
Total Delay		11.2						6.7		11.0	10.4	
LOS		B						A		B	B	
Approach Delay		11.2						6.7			10.6	
Approach LOS		B						A			B	

Intersection Summary

Area Type: Other
Cycle Length: 50
Actuated Cycle Length: 41.8
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.67
Intersection Signal Delay: 8.0 Intersection LOS: A
Intersection Capacity Utilization 42.2% ICU Level of Service A
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↰	↰↑	↱	↰	↰↑↑			↑↑↱	
Volume (vph)	0	0	0	122	311	140	145	253	0	0	79	162
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	100		0	0		0
Storage Lanes	0		0	1		1	1		0	0		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			55			45			45	
Link Distance (ft)		145			222			280			110	
Travel Time (s)		3.3			2.8			4.2			1.7	
Peak Hour Factor	0.92	0.92	0.92	0.71	0.91	0.65	0.68	0.75	0.92	0.92	0.73	0.88
Shared Lane Traffic (%)				10%			20%					
Act Effct Green (s)				12.9	12.9	12.9	18.7	18.7			13.5	
Actuated g/C Ratio				0.31	0.31	0.31	0.45	0.45			0.32	
v/c Ratio				0.30	0.66	0.34	0.35	0.27			0.25	
Control Delay				14.3	20.3	4.2	8.8	7.2			5.5	
Queue Delay				0.0	0.0	0.0	0.0	0.0			0.0	
Total Delay				14.3	20.3	4.2	8.8	7.2			5.5	
LOS				B	C	A	A	A			A	
Approach Delay					14.3			7.7			5.5	
Approach LOS					B			A			A	

Intersection Summary

Area Type: Other
Cycle Length: 50
Actuated Cycle Length: 41.8
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.67
Intersection Signal Delay: 10.3 Intersection LOS: B
Intersection Capacity Utilization 42.2% ICU Level of Service A
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑	↱		↰↑↱		↰	↑↱		↰	↑↱	
Volume (vph)	17	45	15	81	74	87	30	311	52	37	145	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		115	0		0	80		0	0		0
Storage Lanes	0		1	0		0	1		0	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Link Speed (mph)		45			45			45			45	
Link Distance (ft)		361			788			110			2695	
Travel Time (s)		5.5			11.9			1.7			40.8	
Peak Hour Factor	0.71	0.90	0.42	0.88	0.88	0.81	0.63	0.83	0.57	0.66	0.80	0.63
Shared Lane Traffic (%)												
Sign Control		Stop			Stop			Stop			Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 37.4% ICU Level of Service A
Analysis Period (min) 15

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑↑	↑↑		↰	↱
Volume (veh/h)	0	26	109	0	51	11
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.72	0.89	0.92	0.71	0.55
Hourly flow rate (vph)	0	36	122	0	72	20
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	122				141	61
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	122				141	61
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				91	98
cM capacity (veh/h)	1462				838	991

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	18	18	61	61	72	20
Volume Left	0	0	0	0	72	0
Volume Right	0	0	0	0	0	20
cSH	1700	1700	1700	1700	838	991
Volume to Capacity	0.01	0.01	0.04	0.04	0.09	0.02
Queue Length 95th (ft)	0	0	0	0	7	2
Control Delay (s)	0.0	0.0	0.0	0.0	9.7	8.7
Lane LOS					A	A
Approach Delay (s)	0.0		0.0		9.5	
Approach LOS					A	

Intersection Summary			
Average Delay	3.5		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↰↑			↰↰	
Volume (vph)	64	104	0	0	90	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Link Speed (mph)		30	30		30	
Link Distance (ft)		231	221		220	
Travel Time (s)		5.3	5.0		5.0	
Peak Hour Factor	0.67	0.90	0.92	0.92	0.74	0.92
Shared Lane Traffic (%)						
Sign Control		Free	Stop		Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 26.1% ICU Level of Service A
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↰↑↱		↰	↑↑			↑↱	
Volume (vph)	0	0	0	36	66	105	7	57	0	0	54	105
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Link Speed (mph)		30			45			40			40	
Link Distance (ft)		260			110			220			1751	
Travel Time (s)		5.9			1.7			3.8			29.8	
Peak Hour Factor	0.92	0.92	0.92	0.75	0.87	0.85	0.58	0.84	0.92	0.92	0.79	0.64
Shared Lane Traffic (%)												
Sign Control		Stop			Stop			Stop			Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 19.5% ICU Level of Service A
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↱		↰	↑↱		↰	↑↱		↰	↑↱	
Volume (vph)	148	269	45	25	240	20	49	125	15	19	102	69
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	95		0	70		0	100		0	250		0
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		45			45			45			45	
Link Distance (ft)		2427			2704			1751			636	
Travel Time (s)		36.8			41.0			26.5			9.6	
Peak Hour Factor	0.92	0.83	0.64	0.57	0.79	0.55	0.72	0.82	0.54	0.59	0.77	0.72
Shared Lane Traffic (%)												
Act Effct Green (s)	11.5	11.5		11.5	11.5		9.7	10.5		8.3	8.3	
Actuated g/C Ratio	0.42	0.42		0.42	0.42		0.36	0.38		0.30	0.30	
v/c Ratio	0.37	0.26		0.11	0.23		0.15	0.13		0.08	0.21	
Control Delay	11.0	6.4		8.1	6.7		8.0	6.5		12.5	7.8	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	11.0	6.4		8.1	6.7		8.0	6.5		12.5	7.8	
LOS	B	A		A	A		A	A		B	A	
Approach Delay		7.7			6.8			6.9			8.4	
Approach LOS		A			A			A			A	

Intersection Summary

Area Type: Other
Cycle Length: 50
Actuated Cycle Length: 27.3
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.37
Intersection Signal Delay: 7.5 | Intersection LOS: A
Intersection Capacity Utilization 37.2% | ICU Level of Service A
Analysis Period (min) 15

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑	↱	↰	↑				↱↱
Volume (veh/h)	0	0	0	0	49	68	5	221	0	0	0	204
Sign Control		Yield			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.61	0.77	0.63	0.75	0.92	0.92	0.92	0.61
Hourly flow rate (vph)	0	0	0	0	80	88	8	295	0	0	0	334
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	351	311	0	311	645	295	334			295		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	351	311	0	311	645	295	334			295		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	79	88	99			100		
cM capacity (veh/h)	446	600	1085	639	388	745	1225			1267		

Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	80	88	8	295	167	167
Volume Left	0	0	8	0	0	0
Volume Right	0	88	0	0	167	167
cSH	388	745	1225	1700	1700	1700
Volume to Capacity	0.21	0.12	0.01	0.17	0.10	0.10
Queue Length 95th (ft)	19	10	0	0	0	0
Control Delay (s)	16.7	10.5	8.0	0.0	0.0	0.0
Lane LOS	C	B	A			
Approach Delay (s)	13.4		0.2		0.0	
Approach LOS	B					

Intersection Summary			
Average Delay	2.9		
Intersection Capacity Utilization	23.8%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↰	↰↑	↱	↰	↰↑			↑↱	
Volume (vph)	0	0	0	453	209	244	1649	1068	0	0	658	154
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	370		190	0		0	0		0
Storage Lanes	0		0	1		1	1		0	0		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			55			45			45	
Link Distance (ft)		346			373			245			328	
Travel Time (s)		7.9			4.6			3.7			5.0	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)				50%			50%					
Act Effct Green (s)				19.0	19.0	19.0	113.0	113.0			63.0	
Actuated g/C Ratio				0.14	0.14	0.14	0.81	0.81			0.45	
v/c Ratio				1.12	1.08dl	0.68	1.31	1.25dl			0.56	
Control Delay				151.3	114.2	25.5	169.6	55.3			29.2	
Queue Delay				123.6	79.6	0.0	249.6	126.9			0.1	
Total Delay				274.9	193.8	25.5	419.2	182.2			29.2	
LOS				F	F	C	F	F			C	
Approach Delay					168.8			254.1			29.2	
Approach LOS					F			F			C	

Intersection Summary

Area Type: Other
Cycle Length: 140
Actuated Cycle Length: 140
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.37
Intersection Signal Delay: 195.5   Intersection LOS: F
Intersection Capacity Utilization 131.7%   ICU Level of Service H
Analysis Period (min) 15
dl Defacto Left Lane. Recode with 1 though lane as a left lane.

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰	↱					↑↑↱		↰	↰↑	
Volume (vph)	451	62	278	0	0	0	0	2266	1133	362	749	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		485	0		0	0		0	0		0
Storage Lanes	1		1	0		0	0		0	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		55			30			45			45	
Link Distance (ft)		384			311			455			245	
Travel Time (s)		4.8			7.1			6.9			3.7	
Peak Hour Factor	0.93	0.71	0.96	0.92	0.92	0.92	0.92	0.96	0.82	0.92	0.80	0.92
Shared Lane Traffic (%)	41%									23%		
Act Effct Green (s)	19.0	19.0	19.0					94.0		78.0	78.0	
Actuated g/C Ratio	0.14	0.14	0.14					0.67		0.56	0.56	
v/c Ratio	1.25	1.23	0.62					1.19dr		1.37	0.92	
Control Delay	193.1	185.1	12.2					87.2		217.2	26.0	
Queue Delay	549.8	559.1	0.0					61.1		53.9	3.9	
Total Delay	742.9	744.2	12.2					148.3		271.1	29.9	
LOS	F	F	B					F		F	C	
Approach Delay		497.5						148.3			84.9	
Approach LOS		F						F			F	

Intersection Summary

Area Type: Other
Cycle Length: 140
Actuated Cycle Length: 140
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.37
Intersection Signal Delay: 184.8 Intersection LOS: F
Intersection Capacity Utilization 131.7% ICU Level of Service H
Analysis Period (min) 15
dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑↑↑→		↰↰	↑↑
Volume (vph)	32	1045	2354	5	47	980
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0		0	275	
Storage Lanes	1	1		0	1	
Taper Length (ft)	25	25		25	25	
Right Turn on Red		Yes		Yes		
Link Speed (mph)	30		55			55
Link Distance (ft)	648		1229			564
Travel Time (s)	14.7		15.2			7.0
Peak Hour Factor	0.68	0.86	0.90	0.63	0.77	0.94
Shared Lane Traffic (%)						
Act Effct Green (s)	7.2	52.4	40.2		4.3	44.3
Actuated g/C Ratio	0.14	1.00	0.77		0.08	0.85
v/c Ratio	0.19	0.77	0.67		0.22	0.35
Control Delay	25.8	3.6	8.3		29.1	2.6
Queue Delay	0.0	0.0	0.0		0.0	0.0
Total Delay	25.8	3.6	8.3		29.1	2.6
LOS	C	A	A		C	A
Approach Delay	4.5		8.3			4.0
Approach LOS	A		A			A

Intersection Summary

Area Type: Other
Cycle Length: 70
Actuated Cycle Length: 52.4
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.77
Intersection Signal Delay: 6.4 Intersection LOS: A
Intersection Capacity Utilization 55.6% ICU Level of Service B
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑↱		↰	↰↑↱		↰↰	↑↑↑	↱	↰↰	↑↑↑	↱
Volume (vph)	253	30	39	56	22	611	21	1495	27	155	795	62
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	100		0	95		0	460		890	480		830
Storage Lanes	1		0	1		0	2		1	2		1
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			30			55			55	
Link Distance (ft)		296			543			2924			1229	
Travel Time (s)		6.7			12.3			36.2			15.2	
Peak Hour Factor	0.88	0.63	0.70	0.78	0.61	0.84	0.75	0.93	0.84	0.80	0.90	0.70
Shared Lane Traffic (%)	50%			10%								
Act Effct Green (s)	12.6	12.6		21.1	21.1		4.0	30.6	30.6	6.0	37.6	37.6
Actuated g/C Ratio	0.15	0.15		0.24	0.24		0.05	0.35	0.35	0.07	0.44	0.44
v/c Ratio	0.61	0.50		0.17	1.57dr		0.17	0.89	0.05	0.81	0.40	0.12
Control Delay	46.2	32.7		28.4	51.4		43.6	34.4	7.6	67.0	18.5	4.9
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	46.2	32.7		28.4	51.4		43.6	34.4	7.6	67.0	18.5	4.9
LOS	D	C		C	D		D	C	A	E	B	A
Approach Delay		37.7			49.6			34.1			25.5	
Approach LOS		D			D			C			C	

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 86.3
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.96
Intersection Signal Delay: 35.1 Intersection LOS: D
Intersection Capacity Utilization 68.4% ICU Level of Service C
Analysis Period (min) 15
dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Future AM Peak Hour Capacity Analysis

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱						↑↱		↰	↰↑	
Volume (vph)	200	31	118	0	0	0	0	106	90	117	800	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		0	100		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		55			30			45			45	
Link Distance (ft)		437			308			224			280	
Travel Time (s)		5.4			7.0			3.4			4.2	
Peak Hour Factor	0.76	0.82	0.84	0.92	0.92	0.92	0.92	0.85	0.77	0.80	0.82	0.92
Shared Lane Traffic (%)										10%		
Act Effct Green (s)		13.5						12.4		17.9	17.9	
Actuated g/C Ratio		0.33						0.31		0.44	0.44	
v/c Ratio		0.39						0.22		0.28	0.69	
Control Delay		10.6						7.3		9.2	13.0	
Queue Delay		0.0						0.0		0.0	0.1	
Total Delay		10.6						7.3		9.2	13.1	
LOS		B						A		A	B	
Approach Delay		10.6						7.3			12.6	
Approach LOS		B						A			B	

Intersection Summary

Area Type: Other
Cycle Length: 50
Actuated Cycle Length: 40.3
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.69
Intersection Signal Delay: 11.4 Intersection LOS: B
Intersection Capacity Utilization 55.0% ICU Level of Service A
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↰	↰	↱	↰	↰↑			↑↱	
Volume (vph)	0	0	0	530	120	146	24	282	0	0	387	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	100		0	0		0
Storage Lanes	0		0	1		1	1		0	0		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			55			45			45	
Link Distance (ft)		145			222			280			110	
Travel Time (s)		3.3			2.8			4.2			1.7	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)				39%			10%					
Act Effct Green (s)				13.5	13.5	13.5	15.5	13.1			17.2	
Actuated g/C Ratio				0.33	0.33	0.33	0.38	0.33			0.43	
v/c Ratio				0.62	0.62	0.25	0.06	0.30			0.36	
Control Delay				17.5	17.2	3.7	9.4	14.4			8.4	
Queue Delay				0.0	0.0	0.0	0.0	0.0			0.0	
Total Delay				17.5	17.2	3.7	9.4	14.4			8.4	
LOS				B	B	A	A	B			A	
Approach Delay					14.8			14.0			8.4	
Approach LOS					B			B			A	

Intersection Summary

Area Type: Other
Cycle Length: 50
Actuated Cycle Length: 40.3
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.69
Intersection Signal Delay: 12.7 Intersection LOS: B
Intersection Capacity Utilization 55.0% ICU Level of Service A
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑	↱		↰↱		↰	↑↱		↰	↑↱	
Volume (vph)	72	313	80	240	295	18	48	130	250	42	187	114
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		115	0		0	80		0	0		0
Storage Lanes	0		1	0		0	1		0	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Link Speed (mph)		45			45			45			45	
Link Distance (ft)		361			788			110			2695	
Travel Time (s)		5.5			11.9			1.7			40.8	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)												
Sign Control		Stop			Stop			Stop			Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 54.8% ICU Level of Service A
Analysis Period (min) 15

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑↑	↑↑		↰	↱
Volume (veh/h)	0	249	457	0	216	41
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.63	0.78	0.92	0.83	0.54
Hourly flow rate (vph)	0	395	586	0	260	76
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	586				784	293
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	586				784	293
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				21	89
cM capacity (veh/h)	985				330	703

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	198	198	293	293	260	76
Volume Left	0	0	0	0	260	0
Volume Right	0	0	0	0	0	76
cSH	1700	1700	1700	1700	330	703
Volume to Capacity	0.12	0.12	0.17	0.17	0.79	0.11
Queue Length 95th (ft)	0	0	0	0	161	9
Control Delay (s)	0.0	0.0	0.0	0.0	46.5	10.7
Lane LOS					E	B
Approach Delay (s)	0.0		0.0		38.4	
Approach LOS					E	

Intersection Summary			
Average Delay	9.8		
Intersection Capacity Utilization	31.3%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Lane Configurations		↰↑						↑↱		↰↰	↑	
Volume (vph)	72	40	215	0	0	0	0	113	186	97	322	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		231			221			398			220	
Travel Time (s)		5.3			5.0			9.0			5.0	
Peak Hour Factor	0.78	0.84	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.68	0.92	0.92
Shared Lane Traffic (%)												
Sign Control		Free			Stop			Stop			Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 40.8% ICU Level of Service A
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↰↑↱		↰	↑↑			↑↱	
Volume (vph)	0	0	0	94	38	74	11	174	0	0	325	46
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Link Speed (mph)		30			45			40			40	
Link Distance (ft)		260			110			220			1751	
Travel Time (s)		5.9			1.7			3.8			29.8	
Peak Hour Factor	0.92	0.92	0.92	0.54	0.81	0.63	0.63	0.84	0.92	0.92	0.85	0.82
Shared Lane Traffic (%)												
Sign Control		Stop			Stop			Stop			Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 40.8% ICU Level of Service A
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↱		↰	↑↱		↰	↑↱		↰	↑↱	
Volume (vph)	285	459	146	6	187	4	149	69	12	17	117	223
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	95		0	70		0	100		0	250		0
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		45			45			45			45	
Link Distance (ft)		2427			2704			1751			636	
Travel Time (s)		36.8			41.0			26.5			9.6	
Peak Hour Factor	0.58	0.82	0.98	0.31	0.61	0.75	0.54	0.80	0.56	0.63	0.87	0.75
Shared Lane Traffic (%)												
Act Effct Green (s)	36.8	36.8		36.8	36.8		22.3	22.3		9.0	9.0	
Actuated g/C Ratio	0.55	0.55		0.55	0.55		0.33	0.33		0.13	0.13	
v/c Ratio	0.86	0.37		0.05	0.16		0.78	0.09		0.16	0.63	
Control Delay	30.9	8.5		8.2	7.8		38.1	14.5		29.5	14.1	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	30.9	8.5		8.2	7.8		38.1	14.5		29.5	14.1	
LOS	C	A		A	A		D	B		C	B	
Approach Delay		17.7			7.9			31.5			15.0	
Approach LOS		B			A			C			B	

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 67.2
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.86
Intersection Signal Delay: 18.0 — Intersection LOS: B
Intersection Capacity Utilization 53.1% — ICU Level of Service A
Analysis Period (min) 15

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑	↱	↰	↑				↱↱
Volume (veh/h)	0	0	0	0	6	39	16	150	0	0	0	182
Sign Control		Yield			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.75	0.88	0.68	0.92	0.92	0.92	0.92	0.93
Hourly flow rate (vph)	0	0	0	0	8	44	24	163	0	0	0	196
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	214	210	0	210	406	163	196			163		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	214	210	0	210	406	163	196			163		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	98	95	98			100		
cM capacity (veh/h)	688	675	1085	737	525	882	1377			1416		

Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	8	44	24	163	98	98
Volume Left	0	0	24	0	0	0
Volume Right	0	44	0	0	98	98
cSH	525	882	1377	1700	1700	1700
Volume to Capacity	0.02	0.05	0.02	0.10	0.06	0.06
Queue Length 95th (ft)	1	4	1	0	0	0
Control Delay (s)	12.0	9.3	7.7	0.0	0.0	0.0
Lane LOS	B	A	A			
Approach Delay (s)	9.7		1.0		0.0	
Approach LOS	A					

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	23.0%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↰	↰↑	↱	↰	↰↑			↑↱	
Volume (vph)	0	0	0	1081	120	165	547	700	0	0	1720	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	370		190	0		0	0		0
Storage Lanes	0		0	1		1	1		0	0		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			55			45			45	
Link Distance (ft)		346			373			245			328	
Travel Time (s)		7.9			4.6			3.7			5.0	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)				50%			43%					
Act Effct Green (s)				54.0	54.0	54.0	58.0	58.0			55.0	
Actuated g/C Ratio				0.42	0.42	0.42	0.45	0.45			0.42	
v/c Ratio				0.88	0.53	0.24	2.07	1.50dl			1.30	
Control Delay				50.9	30.3	5.4	523.9	92.1			171.5	
Queue Delay				669.7	37.6	0.0	0.0	0.0			115.4	
Total Delay				720.6	67.8	5.4	523.9	92.1			287.0	
LOS				F	E	A	F	F			F	
Approach Delay					318.5			200.0			287.0	
Approach LOS					F			F			F	

Intersection Summary

Area Type: Other
Cycle Length: 130
Actuated Cycle Length: 130
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 2.24
Intersection Signal Delay: 272.1 Intersection LOS: F
Intersection Capacity Utilization 175.9% ICU Level of Service H
Analysis Period (min) 15
dl Defacto Left Lane. Recode with 1 though lane as a left lane.

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑	↱					↑↑↱		↰	↰↑	
Volume (vph)	547	50	1265	0	0	0	0	700	190	805	1996	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		485	0		0	0		0	0		0
Storage Lanes	1		1	0		0	0		0	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		55			30			45			45	
Link Distance (ft)		384			311			455			245	
Travel Time (s)		4.8			7.1			6.9			3.7	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Shared Lane Traffic (%)	46%									21%		
Act Effct Green (s)	54.0	54.0	54.0					49.0		68.0	68.0	
Actuated g/C Ratio	0.42	0.42	0.42					0.38		0.52	0.52	
v/c Ratio	0.46	0.46	2.08					0.51		2.24	1.94	
Control Delay	30.2	30.2	514.9					30.2		582.6	442.9	
Queue Delay	5.7	6.0	0.0					0.1		85.4	63.9	
Total Delay	35.9	36.3	514.9					30.3		668.0	506.9	
LOS	D	D	F					C		F	F	
Approach Delay		361.4						30.3			543.4	
Approach LOS		F						C			F	

Intersection Summary

Area Type: Other
Cycle Length: 130
Actuated Cycle Length: 130
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 2.24
Intersection Signal Delay: 400.1 Intersection LOS: F
Intersection Capacity Utilization 175.9% ICU Level of Service H
Analysis Period (min) 15

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	5	131	759	5	1001	2260
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0		0	275	
Storage Lanes	1	1		0	1	
Taper Length (ft)	25	25		25	25	
Right Turn on Red		Yes		Yes		
Link Speed (mph)	30		55			55
Link Distance (ft)	648		1229			564
Travel Time (s)	14.7		15.2			7.0
Peak Hour Factor	0.55	0.66	0.90	0.44	0.70	0.78
Shared Lane Traffic (%)						
Act Effct Green (s)	6.1	102.3	45.7		46.5	99.5
Actuated g/C Ratio	0.06	1.00	0.45		0.45	0.97
v/c Ratio	0.09	0.13	0.38		0.92	0.84
Control Delay	48.6	0.2	21.3		36.0	5.3
Queue Delay	0.0	0.0	0.0		0.0	0.0
Total Delay	48.6	0.2	21.3		36.0	5.3
LOS	D	A	C		D	A
Approach Delay	2.3		21.3			15.4
Approach LOS	A		C			B

Intersection Summary

Area Type: Other
Cycle Length: 120
Actuated Cycle Length: 102.3
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.92
Intersection Signal Delay: 15.9 Intersection LOS: B
Intersection Capacity Utilization 72.5% ICU Level of Service C
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑↱		↰	↰↑↱		↰↰	↑↑↑	↱	↰↰	↑↑↑	↱
Volume (vph)	17	128	15	38	52	109	82	638	165	523	1309	433
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	100		0	95		0	460		890	480		830
Storage Lanes	1		0	1		0	2		1	2		1
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			30			55			55	
Link Distance (ft)		296			543			2924			1229	
Travel Time (s)		6.7			12.3			36.2			15.2	
Peak Hour Factor	0.64	0.46	0.75	0.64	0.58	0.79	0.65	0.84	0.59	0.80	0.84	0.47
Shared Lane Traffic (%)	10%			10%								
Act Effct Green (s)	11.3	11.3		8.0	8.0		4.0	16.2	16.2	15.9	28.1	28.1
Actuated g/C Ratio	0.17	0.17		0.12	0.12		0.06	0.24	0.24	0.24	0.42	0.42
v/c Ratio	0.09	0.53		0.28	0.48		0.62	0.62	0.47	0.81	0.74	0.83
Control Delay	24.9	28.8		31.6	16.0		47.6	26.4	6.5	35.1	20.0	12.4
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	24.9	28.8		31.6	16.0		47.6	26.4	6.5	35.1	20.0	12.4
LOS	C	C		C	B		D	C	A	D	C	B
Approach Delay		28.5			18.9			23.9			20.9	
Approach LOS		C			B			C			C	

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 67.5
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.83
Intersection Signal Delay: 22.0 Intersection LOS: C
Intersection Capacity Utilization 49.6% ICU Level of Service A
Analysis Period (min) 15

Future PM Peak Hour Capacity Analysis

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱						↑↱		↰	↰↑	
Volume (vph)	148	25	21	0	0	0	0	785	898	134	325	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		0	100		0
Storage Lanes	0		0	0		0	0		0	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		55			30			45			45	
Link Distance (ft)		437			308			224			280	
Travel Time (s)		5.4			7.0			3.4			4.2	
Peak Hour Factor	0.74	0.43	0.53	0.92	0.92	0.92	0.92	0.90	0.90	0.73	0.86	0.92
Shared Lane Traffic (%)										29%		
Act Effct Green (s)		14.2						33.3		29.5	28.6	
Actuated g/C Ratio		0.23						0.54		0.48	0.46	
v/c Ratio		0.38						0.91		0.62	0.41	
Control Delay		20.1						18.1		23.1	11.0	
Queue Delay		0.0						0.0		0.0	0.0	
Total Delay		20.1						18.1		23.1	11.0	
LOS		C						B		C	B	
Approach Delay		20.1						18.1			13.8	
Approach LOS		C						B			B	

Intersection Summary

Area Type: Other
Cycle Length: 65
Actuated Cycle Length: 61.7
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.91
Intersection Signal Delay: 17.5 Intersection LOS: B
Intersection Capacity Utilization 62.9% ICU Level of Service B
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	224	236	176	240	693	0	0	235	199
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	100		0	0		0
Storage Lanes	0		0	1		1	1		0	0		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			55			45			45	
Link Distance (ft)		145			222			280			110	
Travel Time (s)		3.3			2.8			4.2			1.7	
Peak Hour Factor	0.92	0.92	0.92	0.71	0.91	0.65	0.68	0.75	0.92	0.92	0.73	0.88
Shared Lane Traffic (%)				11%			10%					
Act Effct Green (s)				14.2	14.2	14.2	39.5	39.5			25.5	
Actuated g/C Ratio				0.23	0.23	0.23	0.64	0.64			0.41	
v/c Ratio				0.73	0.73	0.56	0.59	0.47			0.36	
Control Delay				34.7	34.4	14.1	9.3	6.0			8.3	
Queue Delay				0.0	0.0	0.0	0.4	0.6			0.0	
Total Delay				34.7	34.4	14.1	9.6	6.6			8.3	
LOS				C	C	B	A	A			A	
Approach Delay					28.0			7.4			8.3	
Approach LOS					C			A			A	

Intersection Summary

Area Type: Other
Cycle Length: 65
Actuated Cycle Length: 61.7
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.91
Intersection Signal Delay: 14.1 Intersection LOS: B
Intersection Capacity Utilization 62.9% ICU Level of Service B
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑	↱		↰↑↱		↰	↑↱		↰	↑↱	
Volume (vph)	20	78	29	180	127	133	70	644	155	57	225	6
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		115	0		0	80		0	0		0
Storage Lanes	0		1	0		0	1		0	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Link Speed (mph)		45			45			45			45	
Link Distance (ft)		361			788			110			2695	
Travel Time (s)		5.5			11.9			1.7			40.8	
Peak Hour Factor	0.71	0.90	0.42	0.88	0.88	0.81	0.63	0.83	0.57	0.66	0.80	0.63
Shared Lane Traffic (%)												
Sign Control		Stop			Stop			Stop			Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 52.8% ICU Level of Service A
Analysis Period (min) 15

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑↑	↑↑		↰	↱
Volume (veh/h)	0	41	203	0	86	19
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.72	0.89	0.92	0.71	0.55
Hourly flow rate (vph)	0	57	228	0	121	35
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	228				257	114
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	228				257	114
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				83	96
cM capacity (veh/h)	1337				710	917

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	28	28	114	114	121	35
Volume Left	0	0	0	0	121	0
Volume Right	0	0	0	0	0	35
cSH	1700	1700	1700	1700	710	917
Volume to Capacity	0.02	0.02	0.07	0.07	0.17	0.04
Queue Length 95th (ft)	0	0	0	0	15	3
Control Delay (s)	0.0	0.0	0.0	0.0	11.1	9.1
Lane LOS					B	A
Approach Delay (s)	0.0		0.0		10.7	
Approach LOS					B	

Intersection Summary			
Average Delay	3.8		
Intersection Capacity Utilization	17.0%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↱		↰	↑↱		↰	↑↱		↰	↑↱	
Volume (vph)	359	445	175	12	402	6	192	90	7	6	85	194
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	95		0	70		0	100		0	250		0
Storage Lanes	1		0	1		0	1		0	1		0
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		45			45			45			45	
Link Distance (ft)		2427			2704			1751			636	
Travel Time (s)		36.8			41.0			26.5			9.6	
Peak Hour Factor	0.92	0.83	0.64	0.57	0.79	0.55	0.72	0.82	0.54	0.59	0.77	0.72
Shared Lane Traffic (%)												
Act Effct Green (s)	41.8	41.8		41.8	41.8		30.2	30.2		18.4	18.4	
Actuated g/C Ratio	0.52	0.52		0.52	0.52		0.38	0.38		0.23	0.23	
v/c Ratio	0.94	0.44		0.08	0.28		0.75	0.09		0.03	0.41	
Control Delay	51.1	9.5		9.4	10.7		36.8	15.7		25.7	9.9	
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	51.1	9.5		9.4	10.7		36.8	15.7		25.7	9.9	
LOS	D	A		A	B		D	B		C	A	
Approach Delay		23.0			10.7			30.1			10.3	
Approach LOS		C			B			C			B	

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 80
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.94
Intersection Signal Delay: 19.5 Intersection LOS: B
Intersection Capacity Utilization 63.8% ICU Level of Service B
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	21	51	148	0	0	0	0	126	300	8	146	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		231			221			270			220	
Travel Time (s)		5.3			5.0			6.1			5.0	
Peak Hour Factor	0.67	0.90	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.74	0.92	0.92
Shared Lane Traffic (%)												
Sign Control		Free			Stop			Stop			Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 45.2% ICU Level of Service A
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↰↑↱		↰	↑↑			↑↱	
Volume (vph)	0	0	0	24	19	183	2	145	0	0	130	113
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Link Speed (mph)		30			45			40			40	
Link Distance (ft)		260			110			220			1751	
Travel Time (s)		5.9			1.7			3.8			29.8	
Peak Hour Factor	0.92	0.92	0.92	0.75	0.87	0.85	0.58	0.84	0.92	0.92	0.79	0.64
Shared Lane Traffic (%)												
Sign Control		Stop			Stop			Stop			Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 45.2% ICU Level of Service A
Analysis Period (min) 15

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑	↱	↰	↑				↱↱
Volume (veh/h)	0	0	0	0	53	80	6	289	0	0	0	380
Sign Control		Yield			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.61	0.77	0.63	0.75	0.92	0.92	0.92	0.61
Hourly flow rate (vph)	0	0	0	0	87	104	10	385	0	0	0	623
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	448	404	0	404	1027	385	623			385		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	448	404	0	404	1027	385	623			385		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	63	84	99			100		
cM capacity (veh/h)	309	530	1085	553	232	662	958			1173		

Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	87	104	10	385	311	311
Volume Left	0	0	10	0	0	0
Volume Right	0	104	0	0	311	311
cSH	232	662	958	1700	1700	1700
Volume to Capacity	0.37	0.16	0.01	0.23	0.18	0.18
Queue Length 95th (ft)	41	14	1	0	0	0
Control Delay (s)	29.5	11.4	8.8	0.0	0.0	0.0
Lane LOS	D	B	A			
Approach Delay (s)	19.7		0.2		0.0	
Approach LOS	C					

Intersection Summary			
Average Delay	3.2		
Intersection Capacity Utilization	30.0%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	88	1361	2976	13	59	1143
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0		0	275	
Storage Lanes	1	1		0	1	
Taper Length (ft)	25	25		25	25	
Right Turn on Red		Yes		Yes		
Link Speed (mph)	30		55			55
Link Distance (ft)	648		1229			564
Travel Time (s)	14.7		15.2			7.0
Peak Hour Factor	0.68	0.86	0.90	0.63	0.77	0.94
Shared Lane Traffic (%)						
Act Effct Green (s)	11.3	81.7	60.1		4.1	66.2
Actuated g/C Ratio	0.14	1.00	0.74		0.05	0.81
v/c Ratio	0.53	1.00	0.89		0.45	0.42
Control Delay	42.2	26.1	16.7		49.5	3.9
Queue Delay	0.0	0.0	0.0		0.0	0.0
Total Delay	42.2	26.1	16.7		49.5	3.9
LOS	D	C	B		D	A
Approach Delay	27.3		16.7			6.7
Approach LOS	C		B			A

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 81.7
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.00
Intersection Signal Delay: 17.5 Intersection LOS: B
Intersection Capacity Utilization 69.3% ICU Level of Service C
Analysis Period (min) 15

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↰↑↱		↰	↰↑↱		↰↰	↑↑↑	↱	↰↰	↑↑↑	↱
Volume (vph)	330	67	88	127	48	799	44	1860	58	188	970	73
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	100		0	95		0	460		890	480		830
Storage Lanes	1		0	1		0	2		1	2		1
Taper Length (ft)	25		25	25		25	25		25	25		25
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			30			55			55	
Link Distance (ft)		296			543			2924			1229	
Travel Time (s)		6.7			12.3			36.2			15.2	
Peak Hour Factor	0.88	0.63	0.70	0.78	0.61	0.84	0.75	0.93	0.84	0.80	0.90	0.70
Shared Lane Traffic (%)	45%			10%								
Act Effct Green (s)	18.0	18.0		43.0	43.0		5.0	53.0	53.0	10.0	59.8	59.8
Actuated g/C Ratio	0.13	0.13		0.31	0.31		0.04	0.38	0.38	0.07	0.43	0.43
v/c Ratio	1.00	0.91		0.30	1.81dr		0.48	1.04	0.11	0.96	0.50	0.14
Control Delay	121.5	78.9		39.0	97.6		79.4	73.7	6.5	111.9	30.5	4.9
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	121.5	78.9		39.0	97.6		79.4	73.7	6.5	111.9	30.5	4.9
LOS	F	E		D	F		E	E	A	F	C	A
Approach Delay		93.4			90.4			71.7			42.1	
Approach LOS		F			F			E			D	

Intersection Summary

Area Type: Other
Cycle Length: 140
Actuated Cycle Length: 140
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.09
Intersection Signal Delay: 70.5 Intersection LOS: E
Intersection Capacity Utilization 84.7% ICU Level of Service E
Analysis Period (min) 15
dr Defacto Right Lane. Recode with 1 though lane as a right lane.

Appendix G

Air Pollutant Emissions Calculations

Proposed Action - Growdon Gate/Road Relocation
Joint Base San Antonio - Lackland
Appendix G - Air Emission Calculations

Contents:

Tables

Emission Calculations:

Construction/Demolition Equipment Emissions:

Construction EF (lb/1,000 ft^2)= Average Construction Equipment Usage Rate (hr/ 1,000 ft^2) x Equipment EF (lb/hr)

Where,
EF = emission factor

Pollutant Emissions (lbs) = Construction EF (lb/1,000 ft^2) x total square feet of construction or demolition

Grading (Non-Road Construction)

Annual PM_{10} emissions = 0.032 ton PM_{10}/acre/month x (total acres) x total months of activity

Source: WRAP 2006, Section 3 PM Emissions from construction.

Concrete Paving Equipment Equipment Emissions:

Paving EF (lb/1,000 yd^3)= Average Paving Equipment Usage Rate (hr/ 1,000 yd^3) x Equipment EF (lb/hr)

Where,
EF = emission factor

Pollutant Emissions (lbs) = Paving EF (lb/1,000 yd^3) x total ft^3 of asphalt/27 ft^3/yard/1,000

Privately Owned Vehicle (POV) and On-Road Diesel Vehicle Emissions

Pollutant emissions = {Total vehicle miles traveled per year (miles/yr) * Pollutant EF (g/mile)}/453.59 g/lb

Where,
EF = emission factor
453.59 g/lb = conversion factor from grams to pounds

Non-Road Equipment Exhaust Emissions:

Pollutant Emissions = {equipment operation (hr/yr)*EF (g/hp-hr)*load factor (%)*horsepower (hp)}/453.59 g/lb

Where,
EF = emission factor
453.59 g/lb = conversion factor from grams to pounds

Evaporative VOC Emissions from Asphalt Paving:

Annual VOC emissions = Total asphalt applied (tons) * EF (lb VOC/ton asphalt)

Where,
VOC = volatile organic compounds

Proposed Action - Growdon Gate/Road Relocation
Joint Base San Antonio - Lackland

Road Construction/Demolition Emissions: Equations and Data

Constants, Source Conditions, and Variables

Variable	Description of Variable	Value PM_{10}	Value $PM_{2.5}$	Units	Reference
k	Particle Size Multiplier	0.35	0.11	-	AP-42 Section 13.2.4 Page 3
U	Mean Wind Speed	9.1	9.1	mph	http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/avgwind.html
M_1	Surface Material Moisture Content (dry)	0.03	0.03	%	AP-42 Table 13.2.2-3
d	Duration of Roadway Construction Activity	12	12	months	Project Dependent
f	Miles to Acres Conversion Factor	12.7	12.7	-	WRAP Fugitive Dust Handbook Table 3-3
M_2	Miles of New Roadway Constructed	1.9	1.9	miles	Project Dependent

Loading Excavated Material to Trucks and Truck Dumping[1]

$$E_{PM10/2.5\ (lb/ton)} = (0.0032k)\frac{(U/5)^{1.3}}{(M_1/2)^{1.4}}$$ Eq. 2, AP-42 13.2.4

Road Construction[2]

PM_{10} Emissions= (0.11 tons PM10/acre/month)*M_2*f*d — WRAP Fugitive Dust Handbook Section 3

$PM_{2.5}$ Emissions= (0.1)(0.11 tons PM10/acre/month)*M_2*f*d — WRAP Fugitive Dust Handbook Section 3

Notes:
[1]Emission factors based upon USACE 1995, Sections 13.2.3 (1/95) and 13.2.4 (1/95)
[2]Emission calculation from the Western Regional Air Partnership (WRAP) Fugitive Handbook (2006) Section 3. Emissions based upon dust control effectiveness of 50% from watering.

Construction Emissions: Calculation Assumptions

General Assumptions

Hours Worked per Day =	8	hr/day	
Days Worked per Year =	250	days/yr (5 days/week x 50 weeks/yr, project duration 1 year)	
Miles of Road Constructed =	1.9	miles (9,000 feet of new road and additional 0.2 miles to account for new gate area)	
Quantity of Road Removed =	18,447	cubic yard (existing Growden Road Removal: 2 ft deep x 249,033 ft^2)*(0.03703704 conversion factor ft^3 to yd^3)	
Density of Road Removed =	3,915	lb/cubic yard (based upon normal weight of reinforced concrete = 145 lbs/cubic foot)	
Mass of Road Removed =	36,110	tons/project (For fugitive dust emissions, conservatively assumed that material removed would be all soil)	

Light Trucks

Number of Trucks =	12	truck	
Hours of Operation per Year =	18,000	hours/yr (assumed in operation 6 hr/day x 250 days/yr)	
Vehicle Mass =	2	ton	
Vehicle Ave.Horsepower =	250	hp	Typical horsepower of light-duty (2 ton) trucks sold in U.S.
Ave. Load Factor =	25	%	Source: USEPA 1991, Off-Highway Trucks

Dump Trucks

Number of Trucks =	10	Dump truck	
Hours of Operation per Year =	15,000	hours/yr (assumed in operation 6 hr/day x 250 days/yr)	
Vehicle Ave.Horsepower =	658	hp	Source: USEPA 1991, Off-Highway Trucks
Ave. Load Factor =	25	%	Source: USEPA 1991, Off-Highway Trucks

Water Trucks

Number of Trucks =	2	Heavy truck	
Hours of Operation per Year =	1,500	hours/yr (assumed in operation 3 hr/day x 250 days/yr)	
Vehicle Ave.Horsepower =	658	hp	Source: USEPA 1991, Off-Highway Trucks
Ave. Load Factor =	25	%	Source: USEPA 1991, Off-Highway Trucks

Proposed Action - Growdon Gate/Road Relocation
Joint Base San Antonio - Lackland

Road Construction/Demolition Emissions: Calculation Assumptions Continued

Forklift			
Number of Forklifts =	1	Forklift	
Hours of Operation per Year =	450	hours/yr (450 hours per vehicle, Based upon similar road construction projects.)	
Vehicle Ave.Horsepower =	150	hp	Typical horsepower.
Ave. Load Factor =	35	%	Source: USEPA 1991, Rough Terrain Forklifts
Scraper			
Number of Scrapers =	2	Scraper	
Hours of Operation per Year =	120	hours/yr (60 hours per vehicle, Based upon similar road construction projects.)	
Vehicle Ave.Horsepower =	1200	hp	Typical horsepower.
Ave. Load Factor =	60	%	Source: USEPA 1991, Scrapers
Large Paver			
Number of Pavers =	1	Large Paver	
Hours of Operation per Year =	750	hours/yr (assumed in operation 3 hr/day x 250 days/yr)	
Vehicle Ave.Horsepower =	400	hp	Typical horsepower.
Ave. Load Factor =	56	%	Source: USEPA 1991, Concrete Pavers
Front-End Loader			
Number of Loaders=	2	Front-End Loader	
Hours of Operation per Year =	1,500	hours/yr (assumed in operation 3 hr/day x 250 days/yr)	
Vehicle Ave.Horsepower =	300	hp	Typical horsepower.
Ave. Load Factor =	38	%	Source: USEPA 1991, Loaders
Concrete Mixer			
Number of Mixing Trucks =	100	Heavy truck	
Hours of Operation per Year =	900	hours/yr (9 hours per vehicle, Based upon similar road construction projects.)	
Vehicle Ave.Horsepower =	300	hp	Typical horsepower.
Ave. Load Factor =	25	%	Source: USEPA 1991, Off-Highway Trucks
Excavator			
Number of Excavator =	1	Excavator ("Caterpillar")	
Hours of Operation per Year =	750	hours/yr (assumed in operation 3 hr/day x 250 days/yr)	
Vehicle Ave.Horsepower =	600	hp	
Ave. Load Factor =	59	%	Source: USEPA 1991, Excavator
Backhoe			
Number of Backhoes =	3	Backhoe	
Hours of Operation per Year =	1,500	hours/yr (500 hours per vehicle, Based upon similar road construction projects.)	
Vehicle Ave.Horsepower =	200	hp	Typical horsepower.
Ave. Load Factor =	38	%	Source: USEPA 1991, Backhoes
Crane			
Number of Cranes =	1	Crane	
Hours of Operation per Year =	300	hours/yr (300 hours per vehicle, Based upon similar road construction projects.)	
Vehicle Ave.Horsepower =	600	hp	Typical horsepower.
Ave. Load Factor =	43	%	Source: USEPA 1991, Off-Highway Trucks
Trackhoe			
Number of Trackhoes =	2	Trackhoe	
Hours of Operation per Year =	400	hours/yr (200 hours per vehicle, Based upon similar road construction projects.)	
Vehicle Ave.Horsepower =	200	hp	Typical horsepower.
Ave. Load Factor =	38	%	Source: USEPA 1991, Backhoes
Steam Roller			
Number of Steam Rollers =	2	Steam Roller	
Hours of Operation per Year =	200	hours/yr (100 hours per vehicle, Based upon similar road construction projects.)	
Vehicle Ave.Horsepower =	100	hp	Typical horsepower.
Ave. Load Factor =	59	%	Source: USEPA 1991, Rollers

Proposed Action - Growdon Gate/Road Relocation
Joint Base San Antonio - Lackland

Road Construction/Demolition Emissions: Calculation Assumptions Continued

Gravel Trucks

Number of Trucks =	150	truck	
Hours of Operation per Year =	900	hours/yr (6 hours per truck , Based upon similar road construction projects.)	
Vehicle Ave.Horsepower =	350	hp	Typical horsepower.
Ave. Load Factor =	25	%	Source: USEPA 1991, Off-Highway Trucks

Grader

Number of Graders =	1	Grader	
Hours of Operation per Year =	300	hours/yr (300 hours per vehicle, Based upon similar road construction projects.)	
Vehicle Ave.Horsepower =	300	hp	Typical horsepower.
Ave. Load Factor =	54	%	Source: USEPA 1991, Graders

Bobcat

Number of Bobcats =	1	Bobcat	
Hours of Operation per Year =	200	hours/yr (200 hours per vehicle, Based upon similar road construction projects.)	
Vehicle Ave.Horsepower =	85	hp	Typical horsepower.
Ave. Load Factor =	48	%	Source: USEPA 1991, Skid Steer Loader

Sheep's Foot Compactor

Number of Compactors =	1	Sheep's Foot Compactor	
Hours of Operation per Year =	300	hours/yr (300 hours per compactor, Based upon similar road construction projects.)	
Vehicle Ave.Horsepower =	300	hp	Typical horsepower.
Ave. Load Factor =	53	%	Source: USEPA 1991, Paving Equipment

Table G-1

Summary of Annual Emissions from All Sources[a]

Growdon Gate/Road Relocation

Joint Base San Antonio - Lackland

Action	Annual Emissions (ton/yr)						
	VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2[b]
Proposed	1.3	8.2	3.0	63.6	6.6	0.93	3,513
No Action	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CO = carbon monoxide

CO_2 = carbon dioxide

NO_x = oxides of nitrogen

$PM_{2.5}$ = particulate matter equal or less than 2.5 micrometers in diameter

PM_{10} = particulate matter equal or less than 10 micrometers in diameter

SO_2 = sulfur dioxide

ton/yr = US (short)tons per year

VOC = volatile organic compounds

Notes:

a It has been assumed that all projects occur during a 1 year duration

b Values shown are in metric tons per year, all other pollutants are US short tons.

Table G-2
Summary of Growdon Road Construction and Existing Road Demolition Emissions
Growdon Gate/Road Relocation
Joint Base San Antonio - Lackland

Loading Excavated Material to Trucks and Truck Dumping (Existing Growdon Road Removal)

Proposed Action	M (moisture content)	U (mean wind speed)	k_{PM10} (particle size multiplier)	$k_{PM2.5}$ (particle size multiplier)	Mass Soil Excavated (ton/yr)	Emission Rates PM_{10} (ton/yr)	Emission Rates $PM_{2.5}$ (ton/yr)
Fugitive Dust	0.030	9.1	0.35	0.11	36,110	**0.87**	**0.27**

New Growdon Road Construction

Proposed Action	M (miles of new Road)	f (conversion factor)	d (duration of project)	EF (PM_{10}/acre/ month)	EF ($PM_{2.5}$/acre/ month)	Emission Rates PM_{10} (ton/yr)	Emission Rates $PM_{2.5}$ (ton/yr)
Fugitive Dust	1.9	12.7	12.0	0.11	0.011	**31.9**	**3.2**

Growden Road Construction and Demolition Equipment Operation (Exhaust Emissions)

Type	Hours Operation (hr/yr)	Horsepower (hp)	Load Factor[a] (%)	Emission Factors[b,c,d,e] PM_{10} (g/hp-hr)	$PM_{2.5}$ (g/hp-hr)	NO_x (g/hp-hr)	CO (g/hp-hr)	SO_2 (g/hp-hr)	VOC (g/hp-hr)	CO_2 (g/hp-hr)
Light Truck	18,000	250	25	0.0092	0.0092	0.276	0.075	0.16	0.1314	530.6
Dump Truck	15,000	658	25	0.0092	0.0092	0.276	0.084	0.16	0.1314	530.6
Water Truck	1,500	658	25	0.0092	0.0092	0.276	0.084	0.16	0.1314	530.6
Scraper	120	1200	60	0.069	0.0690	2.392	0.076	0.16	0.1314	530.6
Large Paver	750	400	56	0.0092	0.0092	0.276	0.084	0.16	0.1314	530.6
Front-end Loader	1,500	300	38	0.0092	0.0092	0.276	0.075	0.16	0.1314	530.6
Concrete Mixer	900	300	25	0.0092	0.0092	0.276	0.075	0.16	0.1314	530.6
Excavator ("Caterpillar")	750	600	59	0.0092	0.0092	0.276	0.084	0.16	0.1314	530.6
Backhoe	1,500	200	38	0.0092	0.0092	0.276	0.075	0.16	0.1314	530.6
Crane	300	600	43	0.0092	0.0092	0.276	0.084	0.16	0.1314	530.6
Trackhoe	400	100	38	0.0092	0.0092	3.0	0.237	0.18	0.1314	590.0
Steam Roller	200	100	59	0.0092	0.0092	3.0	0.237	0.18	0.1314	590.0
Forklift	450	150	35	0.0092	0.0092	0.276	0.087	0.16	0.1314	530.6
Gravel Trucks	900	350	25	0.0092	0.0092	0.276	0.084	0.16	0.1314	530.6
Grader	300	300	54	0.0092	0.0092	0.276	0.075	0.16	0.1314	530.6
Bobcat	200	85	48	0.0092	0.0092	3.0	0.237	0.18	0.1314	590.0
Sheep's Foot Compactor	300	300	53	0.0092	0.0092	0.276	0.075	0.16	0.1314	530.6

Equipment Operation (Exhaust Emissions Continued)

Type	Emission Rates PM_{10} (ton/yr)	$PM_{2.5}$ (ton/yr)	NO_x (ton/yr)	CO (ton/yr)	SO_2 (ton/yr)	VOC (ton/yr)	CO_2 (ton/yr)
Light Truck	0.011	0.011	0.34	0.093	0.20	0.16	657
Dump Truck	0.025	0.025	0.75	0.23	0.43	0.36	1,442
Water Truck	2.50E-03	2.50E-03	0.075	0.023	0.043	0.036	144
Scraper	6.57E-03	6.57E-03	0.23	7.23E-03	0.015	0.013	50.5
Concrete Paver	1.70E-03	1.70E-03	0.051	0.016	0.030	0.024	98.2
Front-end Loader	1.73E-03	1.73E-03	0.052	0.014	0.030	0.025	99.9
Concrete Mixer	6.84E-04	6.84E-04	0.021	5.58E-03	0.012	9.77E-03	39.4
Bulldozer	2.69E-03	2.69E-03	0.081	0.025	0.047	0.038	155
Backhoe	1.16E-03	1.16E-03	0.035	9.42E-03	0.020	0.016	66.6
Crane	7.84E-04	7.84E-04	0.024	7.16E-03	0.014	0.011	45.2
Trackhoe	1.54E-04	1.54E-04	0.050	3.97E-03	3.01E-03	2.20E-03	9.9
Steam Roller	1.20E-04	1.20E-04	0.039	3.08E-03	2.34E-03	1.71E-03	7.7
Forklift	2.39E-04	2.39E-04	7.18E-03	2.26E-03	4.16E-03	3.42E-03	13.8
Gravel Trucks	7.98E-04	7.98E-04	0.024	7.29E-03	0.014	0.011	46.0
Grader	4.92E-04	4.92E-04	0.015	4.01E-03	8.56E-03	7.03E-03	28.4
Bobcat	8.27E-05	8.27E-05	0.027	2.13E-03	1.62E-03	1.18E-03	5.3
Sheep's Foot Compactor	4.83E-04	4.83E-04	0.014	3.94E-03	8.41E-03	6.90E-03	27.9
Totals	**0.057**	**0.057**	**1.8**	**0.45**	**0.89**	**0.73**	**2,937**

Notes:

a Source: USEPA 1991

b Source: USEPA 2004. Assumed Tier 4 for all equipment.

c CO_2 emission factor source: Table 4.9 of USEPA 2009.
Emission factors given in Table 4.9 are based upon the reference in footnote b above. Assumed Tier 4 for all equipment.

d Assumed $PM_{2.5} = PM_{10}$

e Assumed 500 ppm sulfur content.

Table G-3

Summary of Annual Construction Equipment Exhaust Emissions[a]
New Gate Buildings and Demolition of Existing Buildings
Growdon Gate/Road Relocation
Joint Base San Antonio - Lackland

Action	Annual Emissions (ton/yr)						
	VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2
Proposed	0.029	0.14	0.43	0.026	0.026	0.028	91.3

CO = carbon monoxide

CO_2 = carbon dioxide

NO_x = oxides of nitrogen

$PM_{2.5}$ = particulate matter equal or less than 2.5 micrometers in diameter

PM_{10} = particulate matter equal or less than 10 micrometers in diameter

SO_2 = sulfur dioxide

ton/yr = US (short)tons per year

VOC = volatile organic compounds

Action =	Proposed	
Total New Gate Building Construction[b] =	8,460	square feet/year
Total Existing Gate Building Demolition =	4,230	square feet/year

Notes:

a It has been assumed that the project has a 1 year duration.

b It has been assumed that the buildings for the new gate will be twice that of the existing buildings.

Table G-4
Building Construction Emission Factors
Growden Gate/Road Relocation
Joint Base San Antonio - Lackland

Average Construction Equipment Usage Rates (hours)[a]				Equipment Emission Factors[b,c,d,e]						
	New Construction		Existing							
Construction Equipment	Single Story (per 1,000 ft^2)	Multi-Story (per 1,000 ft^2)	Demolition (per 1,000 ft^2)	VOC (lb/hr)	CO (lb/hr)	NO_X (lb/hr)	PM_{10} (lb/hr)	$PM_{2.5}$ (lb/hr)	SO_2 (lb/hr)	CO_2 (lb/hr)
Backhoe	2.6901	2.1943	-	0.007	0.084	0.107	0.011	0.011	0.006	21.0
Blower	-	-		0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bulldozer	1.1833	1.3866	-	0.077	0.390	1.157	0.069	0.069	0.074	245
Concrete Truck	7.5282	3.7641	-	0.143	0.720	2.138	0.128	0.128	0.137	454
Crane	10.3343	15.5449	3.000	0.034	0.137	0.459	0.028	0.028	0.029	97.5
Dump Truck	4.2281	3.4009	7.960	0.143	0.720	2.138	0.128	0.128	0.137	454
Front-end Loader	2.6800	2.5183	4.000	0.015	0.070	0.202	0.018	0.018	0.013	43.0
18-Wheel Truck	28.0799	30.0545	-	0.143	0.720	2.138	0.128	0.128	0.137	454

Pollutant	Construction Equipment Emission Factors		
	New Construction		Existing
	Single Story (lb/1,000 ft^2)	Multi-Story (lb/1,000 ft^2)	Demolition (lb/1,000 ft^2)
VOC	6.2	6.0	1.3
CO	31.0	29.9	6.4
NO_X	92.1	89.1	19.2
PM_{10}	5.6	5.4	1.2
$PM_{2.5}$	5.6	5.4	1.2
SO_2	5.9	5.7	1.2
CO_2	19,544	18,898	4,076

CO = carbon monoxide
CO_2 = carbon dioxide
g/hp-hr = gram per horsepower - hour
hp = horsepower
lb = pound
lb/hr = pound per hour
NO_x = nitrogen oxides
PM_{10} = particulate matter equal or less than 10 micrometers in diameter
$PM_{2.5}$ = particulate matter equal or less than 2.5 micrometers in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound
yd^3 = cubic yard

Notes:
a Source: Means 1996
b Source: USEPA 2004. Assumed Tier 3 for all equipment.
The g/hp-hr emission factors converted to lb/hr; using horsepower from USEPA 1991, Table 2-04 and NONROAD2008 load factor.
c CO_2 emission factor source: Table 4.9 of USEPA 2009.
Emission factors given in Table 4.9 are based upon the reference in footnote b above. The g/hp-hr emission factors converted to lb/hr; using horsepower from USEPA 1991, Table 2-04 and NONROAD2008 load factor. Assumed Tier 3 for all equipment.
d Assumed $PM_{2.5}$ = PM_{10}
e Assumed 500 ppm sulfur content.

Table G-5

Summary of Emissions from Construction POV[a]

Growdon Gate/Road Relocation

Joint Base San Antonio - Lackland

Car/Light Truck (Exhaust Emissions)

Action	Days worked	Total Number of Worker Vehicles	Vehicles Miles Traveled (miles/day)	Vehicles Miles Traveled (miles/Action)	Emission Factor (g/mile)						
					CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	CO_2
Proposed	250	20	100	500,000	13.47	0.81	0.025	0.0115	0.0094	0.919	514.3

Car/Light Truck (Exhaust Emissions Continued)

Action	Annual Emissions (ton/yr)						
	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	CO_2
Proposed	7.4	0.45	0.014	6.34E-03	5.18E-03	0.51	283

CO = carbon monoxide

CO_2 = carbon dioxide

g/mile = gram mile

NO_x = oxides of nitrogen

$PM_{2.5}$ = particulate matter equal or less than 2.5 micrometers in diameter

PM_{10} = particulate matter equal or less than 10 micrometers in diameter

POV = privately owned vehicle

SO_2 = sulfur dioxide

ton/yr = US (short)tons per year

VOC = volatile organic compounds

Notes:

a Construction worker private vehicle travel to the work site. Conservatively assumed every POV would travel 100 miles per day for each day worked.

a Emission Factor Source: USEPA 2003c
(MOBILE6.2, 24-Sep-2003). Assumed all LDGT vehicle class traveling an average speed of 45 mph.

Table G-6
Summary of On-Road Diesel Vehicle Combustion Emissions
Growdon Gate/Road Relocation
Joint Base San Antonio - Lackland

Action	Annual Emissions (ton/yr)						
	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	CO_2
Proposed Action	0.18	0.28	0.018	0.014	1.63E-03	0.077	174

CO = carbon monoxide

CO_2 = carbon dioxide

g/mile = grams per mile

mph = miles per hour

$PM_{2.5}$ = particulate matter equal or less than 2.5 micrometers in diameter

PM_{10} = particulate matter equal or less than 10 micrometers in diameter

NO_x = oxides of nitrogen

SO_2 = sulfur dioxide

ton/yr = US (short)tons per year

VMT = vehicle miles traveled

VOC = volatile organic compounds

Notes

a Annual emissions = MOBILE6 EF (g/mile) * Annual VMT

MOBILE6 Vehicle Type Category[a]	LDDT[b]	HDDV3[c]	
Roadway Type	Paved[d]	Paved[d]	
Annual Average VOC Emission Factor :	0.336	0.250	g/mile
Annual Average NO_x Emission Factor :	0.597	2.125	g/mile
Annual Average CO Emission Factor :	0.615	0.955	g/mile
Annual Average CO_2 Emission Factor :	598.3	874.8	g/mile
Annual Average SO_2 Emission Factor :	0.0056	0.0082	g/mile
Annual Average PM_{10} Emission Factor :	0.0724	0.0743	g/mile
Annual Average $PM_{2.5}$ Emission Factor :	0.0550	0.0541	g/mile

	Proposed Action		
	LDDT[e]	HDDV3[f]	
Total Annual VMT	150,000	77,367	miles/yr

Notes:

a Emission Factor Source (year 2011): USEPA 2003c (MOBILE6.2).

b LDDT = Light duty diesel powered trucks (i.e., includes diesel pickup trucks, sport utility vehicles and vans with GVWR ≤ 8,500 pounds.)

c HDDV3 = Heavy duty diesel powered vehicles (i.e., includes diesel trucks and buses with GVWR 10,001 - 14,000 pounds.)

d Assumed all vehicles travel average speed of 45 mph.

e LDDT VMT based upon 12 vehicles traveling 50 miles/day for 250 working days.

f HDDV3 VMT based upon 5 loads/day of delivery (250 days/project) and 10 yd^3 haul trucks for transporting excavated existing Growdon Road. Average trip length of 25 miles for all trucks.

Table G-7

Summary of Fugitive Grading Emissions[a]

Growdon Gate/Road Relocation

Joint Base San Antonio - Lackland

New Growdon Gate Area

Proposed Action	A (total acres)	d (duration of project)	EF (PM_{10}/acre/month)	EF ($PM_{2.5}$/acre/month)	Emission Rates PM_{10} (ton/yr)	Emission Rates $PM_{2.5}$ (ton/yr)
Fugitive Dust	80.0	12.0	0.032	0.0032	**30.7**	**3.1**

Equipment Operation (Exhaust Emissions)

Type	Hours Operation (hr/yr)	Horsepower (hp)	Load Factor[b] (%)	Emission Factors[c,d,e,f] PM_{10} (g/hp-hr)	$PM_{2.5}$ (g/hp-hr)	NO_x (g/hp-hr)	CO (g/hp-hr)	SO_2 (g/hp-hr)	VOC (g/hp-hr)	CO_2 (g/hp-hr)
Light Truck	120	250	25	0.0092	0.0092	0.276	0.075	0.16	0.1314	530.6
Dump Truck	120	658	25	0.0092	0.0092	0.276	0.084	0.16	0.1314	530.6
Grader	120	300	54	0.0092	0.0092	0.276	0.075	0.16	0.1314	530.6

Equipment Operation (Exhaust Emissions Continued)

Type	Annual Emissions (tons/yr) PM_{10}	$PM_{2.5}$	NO_x	CO	SO_2	VOC	CO_2
Light Truck	7.60E-05	7.60E-05	2.28E-03	6.19E-04	1.32E-03	1.09E-03	4.4
Dump Truck	2.00E-04	2.00E-04	6.00E-03	1.83E-03	3.48E-03	2.86E-03	11.5
Grader	1.97E-04	1.97E-04	5.91E-03	1.61E-03	3.43E-03	2.81E-03	11.4
Totals	**4.73E-04**	**4.73E-04**	**0.014**	**4.05E-03**	**8.23E-03**	**6.76E-03**	**27.3**

Notes:

a It was conservatively assumed that the entire new Growdon Gate area of 80 acres would require grading. Assumed 4 weeks for completion.

b Source: USEPA 1991

c Source: USEPA 2004. Assumed Tier 4 for all equipment.

d CO_2 emission factor source: Table 4.9 of USEPA 2009

Emission factors given in Table 4.9 are based upon the reference in footnote b above. Assumed Tier 4 for all equipment.

e Assumed $PM_{2.5} = PM_{10}$

f Assumed 500 ppm sulfur content.

Table G-8
Fugitive Emissions from Asphalt Paving
Growdon Gate/Road Relocation
Joint Base San Antonio - Lackland

Action	Total Asphalt (tons)	Factor[a] (lb VOC/ton of asphalt)	Emission Rate (ton/yr)
			VOC
Proposed Action	208	0.0014	1.46E-04

lb =pound

ton/yr= tons per year

VOC = volatile organic compound

Density of Asphalt	68.56	lb/ft^3
Proposed Action	208	tons/year

Notes:

a Assumed 8" asphalt thickness. Based upon new road having 12' wide lanes and 2' shoulders and a gate area of 158,400 ft^2.

b Source: USEPA 1995, Section 11.1.2.5, (updated 3/2004).